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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF
FOREST FIRE CONTROL

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Forest Service
UNITED STATES DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

UNITED STATES DEPARTMENT OF AGRICULTURE 1862 1962

Growth Through Agricultural Progress

Volume 23 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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A KEY TO BLOWUP CONDITIONS IN THE SOUTHWEST?

ROBERT W. BATES
District Ranger, Tonto National Forest

Can minimum nighttime temperatures be used in some areas as an indicator of one type of blowup conditions? A preliminary study of several project fires occurring on the Tonto, Sitgreaves, and Prescott National Forests in the years 1951 to 1961 showed that the night before each of these fires blew out of control was unusually warm. Of particular significance is the fact that most of them occurred following the warmest nights of the critical June fire period and often occurred at a peak after several consecutive days of rapidly rising temperatures. For some fires which occurred in July and September this also appeared to be true. Only 4 of the 13 fires in the study failed to show this, but even for those 4 the temperatures were at or above what is believed to be the critical point. Temperatures on the nights preceding the start, or blowup, of these fires varied from high of 81° in the semidesert to 52° in the pine above the Mogollon Rim. These temperatures were all unusually high for the area where the fire occurred.

Why, in June, are some fires controlled at small size while others defy control no matter what the action taken? Why can you reach some lightning fires while they are still in the tree, yet others explode into major fires? Why does a quiet or apparently controlled fire suddenly act up? A look at relative humidity showed day-to-day fluctuations and seemed not to be an adequate answer to these questions. This study seems to indicate that a deadly one-two combination of an unusually warm night followed by a warm day may be the key.

If further study should prove this to be reliable, we could determine more accurately when to increase emergency fire forces and signal the start of intensive fire prevention. Following lightning, extra efforts to ensure early detection could be undertaken. By taking 8:00 a.m. readings of the previous night's minimum temperature and plotting them on a graph, it might be possible to spot the beginning of potential blowup conditions. There is usually a very sharp rise from relatively cool nights to hot nights over a period of only 2 or 3 days (figs. 1-4). Since this leaves very little time to get ready, the use of nighttime temperatures may be a better indicator than daytime temperatures because it allows more time to prepare.

Too, the charts on the 13 fires studied actually indicate a better tie-in using minimum rather than maximum temperatures.

Fire control organizations are not fully aware of this change in conditions as it is not indicated in present fire-danger meters by any definite rise in the index During June, the Southwest is in extreme conditions already—so it might be said that conditions have suddenly gone from critical to supercritical.

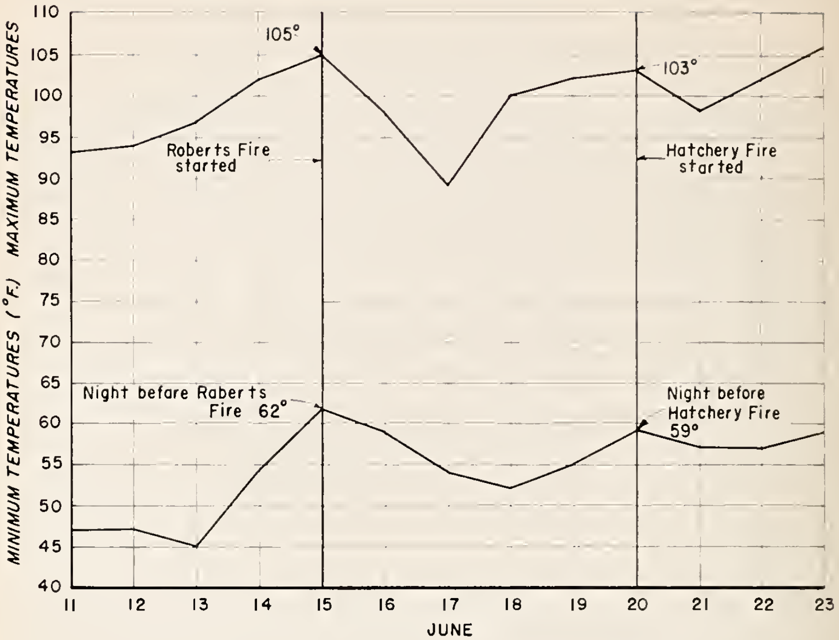

FIGURE 1.—Roberts and Hatchery Fires, June 1961.

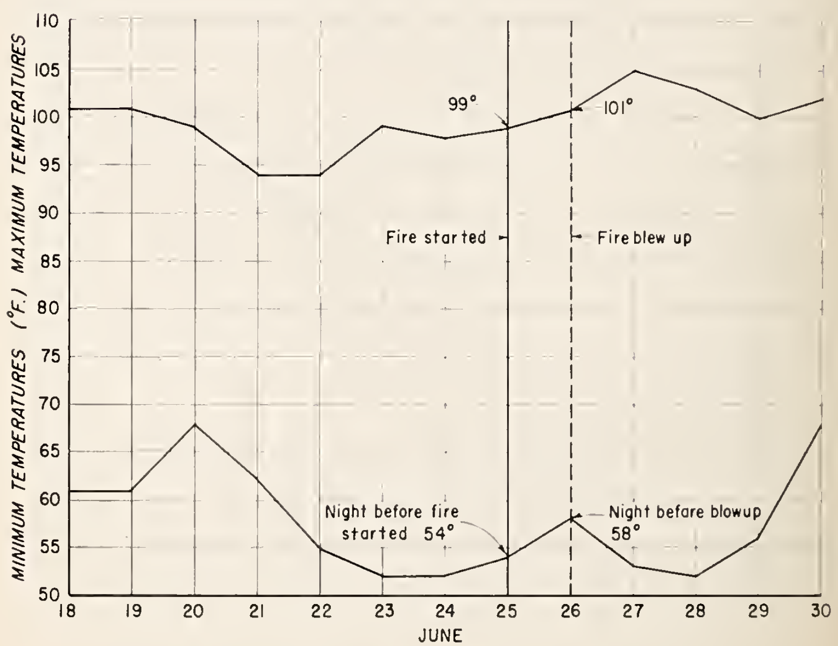

FIGURE 2.—Russell Gulch Fire, June 1951.

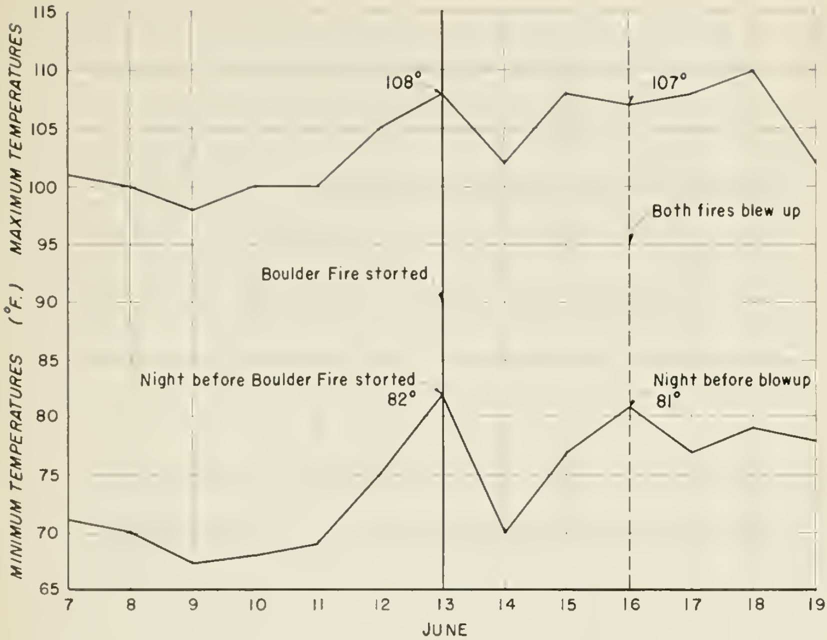

FIGURE 3.—Boulder and Pranty Fires (lightning), June 1959.

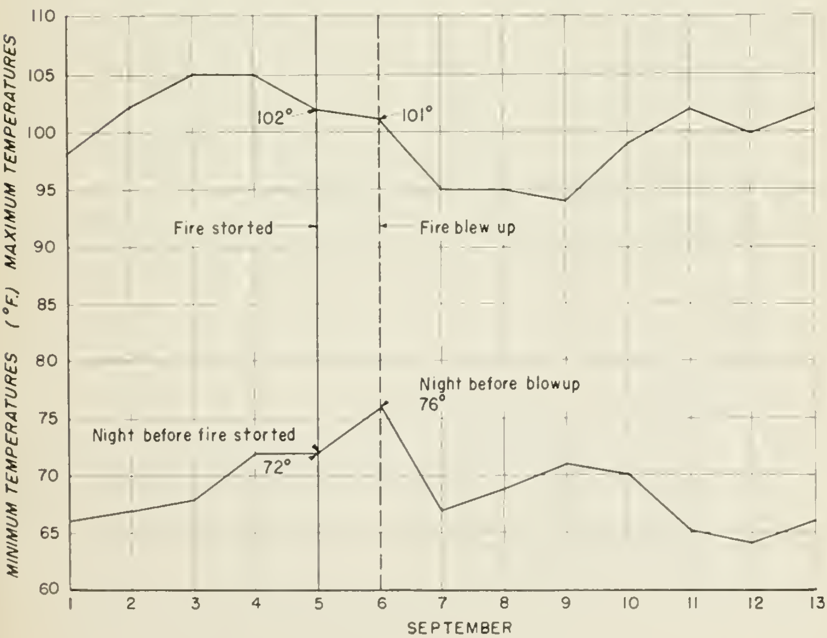

FIGURE 4.—Buckhorn Fire, September 1956.

An attempt to expand on this theory and determine an average date at which this temperature rise occurred proved futile. It can apparently happen almost any time in June in this area and may occur as early as May or as late as July in other southwestern localities. In 1956, the condition seems to have appeared in September on the Tonto National Forest on the Buckhorn Fire, coinciding with a dry fall period. However, June 10 is often mentioned as the breaking point on the Tonto. Each forest—possibly each district—would have to chart this separately and watch for the start of the temperature rise. From this temperature study, I have arbitrarily said that nighttime temperatures above 45° are critical; and with those above 55° blowup conditions exist. Cloudy nights keep nighttime temperatures high and may or may not be serious depending on whether the clouds disappear by morning. During June, there is probably only a small likelihood of nighttime clouds.

It is recognized that factors other than temperatures also contribute to fire size. Some areas have large fires during periods of high early spring winds; some fires are large because of organizational breakdowns, others because of topography; California has its Santa Ana winds; and so on. Undoubtedly, most of these fires would show temperature correlation only through coincidence. On the fires studied there was no attempt to make a complete analysis of all factors affecting the particular fire such as topography, wind, relative humidity, human error, time of day, fuels, and aspect. What was suggested by the study is that this one common denominator may provide a predictable basis for increased manning and a crash prevention effort during the critical periods.

Some assumptions and recommendations that can be made from this limited study follow.

1. High nighttime temperatures do not of themselves cause fires to blow up, but under these conditions, all other factors which tend to cause large fires are maximized.

2. If nighttime temperatures are rising, going fires must be secured before temperatures rise above the critical point. This is seen in the case of fires which blow up on the third or fourth day after start.

3. Fires occurring before and after temperature peaks are controlled at small size; some of them under much worse rate-of-spread conditions.

4. Spotting was a big factor in most of these fires although winds were not exceptionally strong. This fact was mentioned consistently in discussing these fires with people who had participated in the suppression. Some of these fires became big even though firefighters were on them at the very start when they were only a few feet across.

5. In June, before the summer lightning period, temperatures can be used as the basis for increased prevention effort at all levels.

6. When lightning occurs, detection forces could be augmented, especially in the case of long aerial patrol routes where some areas are not covered until 3 or 4 hours after daylight.

7. It might be possible to develop new rules for prescribed burning. Limit burning to times when nighttime temperatures are less than 45° and to a time when the temperature trend is down.

8. In the June dry period, rapidly rising nighttime temperatures often seem to presage the first lightning storm of the season. These high nighttime temperatures usually occur from 24 to 48 hours before the lightning storms occur. These first storms are often dry.

☆ ☆ ☆

Bag-In-A-Box Milk Containers for Fire Use

During the past year, milk companies have been delivering milk to restaurants, ice-cream drive-ins, and other users in a 6-gallon double plastic bag inside a cardboard box. These containers are usually thrown away after they are emptied and removed from the dispenser.

These containers can provide a useful supplementary water supply that is easily handled, transported, and stored. They can be kept filled with 5 gallons of water even during freezing weather since they cannot be damaged by ice expansion. The containers might be placed in storage sheds, attics, and other locations where the water would be available for use on small fires.

The containers can be carried in cars or trucks to provide an instant refill for backpack cans. They can be strategically dropped where a firefighter can go to refill his can.

A small folding harness was designed by Randall to enable the firefighter to carry a container for use in mopup work. The small rubber hose which protrudes from the bag can be clamped to provide a shutoff so that water can be dribbled onto burning embers or small logs in the same manner as water from a backpack can.

The best part of all is that the containers are free for the asking from most milk users, and if they wear out or are otherwise damaged, there is no replacement cost.—CLAUDE H. RANDALL, *Chief, Havana Rural Fire Department, and* GORDON O. CECH, *District Forester, Illinois Division of Forestry, Havana, Illinois.*

LET'S HANG ON TO COLOR SLIDES—THEY'RE VALUABLE

ALVA G. NEUNS
Information Specialist, Forest Service, USDA

Color slides have come to be recognized as very valuable assists to all types of presentation for the purpose of increasing understanding—I&E, training, in-Service staff meetings, cooperative technical sessions and extension work, to name a few.

Slides offer many advantages for these purposes. They are lightweight, occupy small space, and can be mailed ahead with written manuscripts. Projectors for them are lightweight and usually available.

But some of these advantages lead to disadvantages. Slides are expensive in spite of the fact that it is easy to photograph 20 to 36 on a camera loading. Copies are equal in cost to the original or master slide. This leads to a tendency to use the master slides for projection, as one would for home shows, and damage often results.

Unlike a B&W photographic negative, an original slide can serve for either positive projection or as the means to obtain color print enlargements. Because such enlargements are very expensive and do not serve a publishing purpose, master slides are not classed as negative material and usually no permanent, central system or file is set up for them except in small specialized units where they are kept as photographic records.

So, color slides land in desk drawers. They stack up in assorted boxes on shelves. The best, often once-in-a-lifetime chances, and most usable slides from a number of boxes are removed and combined for specific showings and these, in turn, are put in more boxes.

Soon, the ease with which slides can be utilized in infinite combinations with other slides in series becomes a disadvantage because single slides are often "lost" among dozens of others. To go through hundreds of slide combinations to find or relocate one is time consuming. And slides are often "lost" in other agency collections while on loan. They are hard to keep track of unless they are strongly identified.

To collect, edit, catagorize, put in series, title, number, label, and caption color slides for permanent use by many people is hard work. It takes selective judgment to cull slides and to keep the right ones and arrange them in usable subject-matter combinations. No matter what file or distribution system you eventually use, this job must be done. Once done then it is important to keep the slides in order.

Next it is important for people to determine quickly whether there are any slides on a subject and what they show. If slides can also be checked in and out easily and fast and a simple record

maintained of when they went out on loan and to whom, one person, located nearby, can oversee the system. Or, if no one is present, sometimes the borrower should be able to review slide content and check them out or in himself.

To meet all of these specifications, a visual file and distribution rack for color slides was designed (fig. 1). It took advantage of the fact that some of the local slide processors are returning mounted slides in transparent plastic boxes. These 2- by 2- by 1¼-inch, lightweight boxes are available in most areas at wholesale prices and quantities. They have hinged snaplock covers, are excellent protection for the slides from dust and damage, and are

FIGURE 1.—This slide distribution rack is being used as a review and check-out unit for a research staff.

easy to handle and store. The slides can be counted and identified without opening the box—an added damage-prevention factor.

The rack was built by the Pacific Southwest Station's Fire Research Division. It is mounted on the wall facing the secretary's desk. The Division's entire collection of color slide copies (masters are filed separately) are immediately available for review and/or use by both the research staff and their cooperators for talks, briefing sessions, project review, and other presentations. Each transparent plastic box has the Station's name and return address on the cover. A card, 2 inches square, is first filled out with the Subject or Title, Series No., Copy No., Location, Date, and Author. The card is then dropped face down into the bottom of the box and the slides placed on top of it. Another card, 2 by 3¼ inches, showing identical information as the square one is also filled out when the slides are edited and identified. This card has one column for "Loaned to" and one for the date loaned; it is placed in the rack behind the box of slides. As can be seen in figure 1, the whole collection, when installed in the rack as shown, can be readily and easily reviewed.

It takes but a few moments for the secretary to fill out the check-out card and replace it in the rack. If the borrower wishes to take only 1 or 2 slides from a category, the slide numbers are entered on the check-out card and the box is replaced with the cover side out. This way a glance at the rack will show what slides are out on loan and who has them.

Master slides should always be filed elsewhere and regarded as negative material for copying; they should not be loaned for projection. They should also, of course, be categorized and identified exactly as the distribution copies are.

The rack shown here can be any size that wall space permits. This one is mounted on one standard 4- by 6-foot sheet of mahogany plywood and matches the mahogany wall paneling on an adjacent wall.

THE PROTECTION OF VEHICLES IN BUSHFIRES

I. S. Walker [1]

Research Officer, Bushfire Section, Division of Physical Chemistry, C.S.I.R.O. Chemical Research Laboratories, Melbourne, Australia.

Motor vehicles engaged in bushfire fighting should be protected against radiant heat, since at times they need to be used close to intense flames, and in an emergency they may be used as refuges for firefighters.

Three major problems arise from radiation:

1. The tires may decompose somewhat, causing rapid loss of strength with the likelihood of deflation, and at times tires may actually ignite.
2. The body panels of the vehicle may be heated to the temperature where paint finishes decompose to give off unpleasant or toxic vapors both inside and outside the vehicle, and at times physical deformation of the metal work will cause doors and windows to jam.
3. The motor may overheat; this results in loss of power. Vapor locking in the fuel system may occur and lead to stalling of the motor and to starting difficulties.

The Heat Reflecting Properties of Aluminum Paint

The only surfaces that reflect to any great extent infra-red radiation, as emitted by normal flames, are those of some polished metals. Thus aluminum which has such a power could well be used in the construction of vehicles. Even after continued use unpainted aluminum could still be expected to reflect 60 to 70 percent of the radiation falling on it.

Paints containing aluminum powder have been measured by radiometer for their reflectance of normally expected infra-red radiation. The absorbing element of the radiometer was either blackened or painted with the paint under test. The reflectance figures and general properties of three paints tested are shown in table 1. Clearly, such paints could give protection to those parts of the vehicle that are likely to be affected by heat, e.g., external steel work and the sides of the tires.

Tire sections, untreated and painted with two suitable paints, were subjected to two different intensities of radiation (table 2). After 40 minutes exposure the untreated tire showed much greater deterioration (fig. 1). This lengthy exposure would only be experienced in unusual situations (e.g., in mopping-up procedures where vehicles may be parked adjacent to burning heaps of heavy fuel).

[1]The author is grateful to Mr. B. Oglethorpe, Technical Manager, Automotive Division, Dunlop Rubber Australia Ltd., for his technical advice, and to Dr. A. R. King, Division of Physical Chemistry, C.S.I.R.O., and Mr. A. G. MacArthur, Forestry and Timber Bureau, Canberra, for helpful criticism.

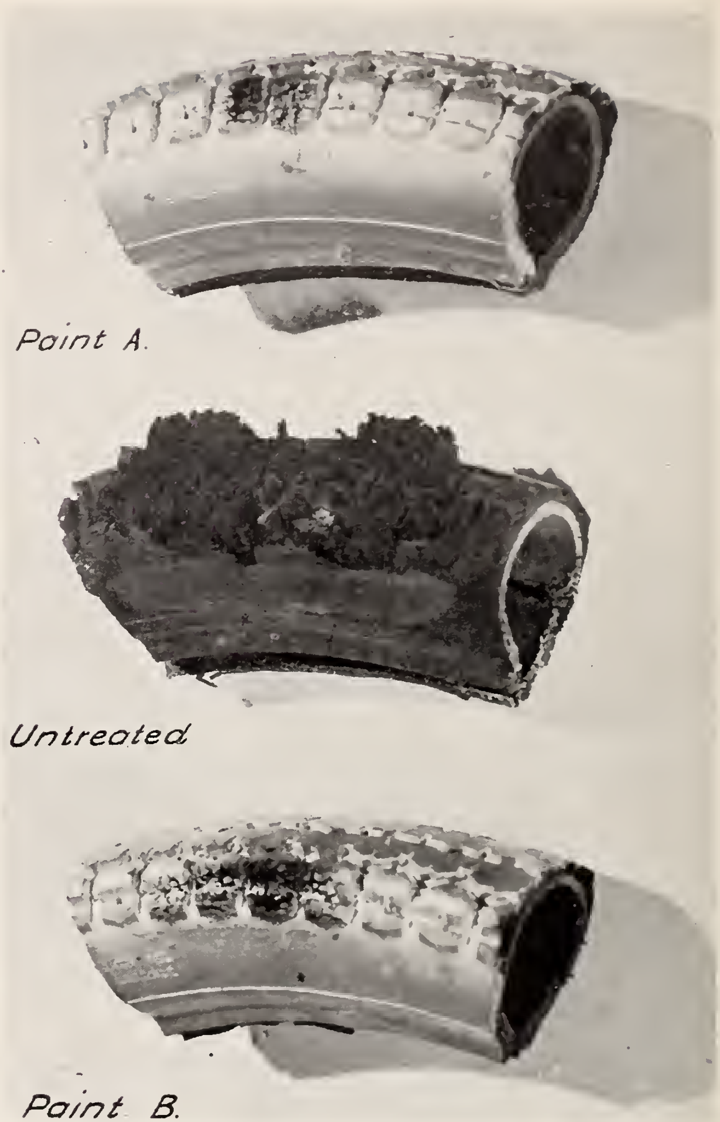

FIGURE 1.—Effect of 40 minutes irradiation on tire sections untreated and protected by aluminum paint.

In many cases it is quite possible that the inner tube would fail well before the tire had seriously decomposed since the tube will be more sensitive to heat, which is conducted to it not only through the tire wall but also by the hot wheel rim. Also over a period of time the lives of both tires and tubes are likely to be shortened greatly by frequent exposures to even comparatively low radiation intensities.

Actual experience indicates that tires, particularly if new, should be well cleaned with a solvent before they are painted, and the first coat should preferably be applied by brushing. In fact,

TABLE 1.—*Properties of aluminum heat-reflecting paints applied to tires*

Paint	Heat reflection average [1]	Heat reflection maximum [2]	Mechanical adherence to rubber	Method of application and covering power	Drying time, approximate
	Percent	*Percent*			*Minutes*
A	66	69	Excellent	Brush: use from the tin (800 sq. ft. per gal.). Spray:[3] dilute with 10-15 percent mineral turpentines (600-700 sq. ft. per gal.).	45
B	60	66	Good, but surface has a tendency to crack	Brush or spray,[3] use from the tin (covering power same as paint A).	20
C	49	52	(4)	(4)	(4)

[1] Obtained from measurements carried out at radiant heat fluxes of 0.07, 0.11, 0.17, and 0.35 cal./cm.^{2}/sec.; maesurements at each intensity.

[2] Obtained at 0.17 cal./cm.^{2}/sec. and below.

[3] Spraying however is not recommended.

[4] Surface remained tacky, even after several days, though finish appeared good. Pigment became mobile in base on heating. Rejected as unsatisfactory.

subsequent coats when brushed on give finishes that are somewhat superior (for the present purpose) to those obtained by spraying. In an emergency when the vehicle becomes a refuge, the outer surface of the windows could well be rendered reflecting by paint applied either by brush or, less desirably, by spray (paint contained in a "pressure pack"). Possibly though, a more appropriate method would be to cover windows with pieces of thin (0.005- to 0.020-inch) aluminum foil which could be pre-cut to size. In most emergency situations there would be sufficient time for the use of such protective devices on the windows. Two objections have been raised to the painting of vehicles with aluminum paint. These are that the vehicle becomes less easily seen in dense smoke and that the glare from the bonnet and body tends to dazzle the vehicle driver and other persons in the vicinity. However, actual experience with one vehicle (the Mobile Laboratory, C.S.I.R.O. Bushfire Section) has shown that these problems are not serious.

Minimum of Fuel Vapor Locking

An electrically operated gasoline pump installed adjacent to the gasoline tank (preferably below it so that the pump is gravity fed) will almost entirely eliminate the possibility of vapor locking. The gasoline will thus be pushed to the carburetor and not drawn to it by suction. Only when the gasoline in the tank is itself actually boiling will the problem become serious and this fortunately is a rare occurrence. A pump of this kind need not replace the pump already installed in a vehicle, but can be used as an auxiliary pump to be switched into use from the dash when the occasion arises.

TABLE 2.—*Heat irradiation tests on 6-inch sections 2¾- by 19-in tires*

Radiation intensity and tire treatment	Time till— Smoking	Cracking	Glowing
	Minutes	*Minutes*	*Minutes*
0.35 cal./cm.^{2}/sec.:[1]			
Untreated	⅓	3	3½
Paint A	1¾	5–6	8¼
Paint B	1¾	8–9	11½
0.17 cal./cm.^{2}/sec.:[2]			
Untreated[3]	¾–1	5½	[4] 10½; 15¾
Paint A	4½	21	[4] 40
Paint B	3¼	18¼	[4] 40

[1] Radiant intensity equivalent to the average usually encountered 5 feet above ground at 5 feet from 10- to 20-foot flames.

[2] Radiant intensity equivalent to the average usually encountered at ground level 5 feet from 10- to 20-foot flames.

[3] These are the results of two tests; the time to glowing is governed in part by the specific way in which the surface cracks.

[4] Pilot ignition immediate for the untreated tire and at 40 minutes took 4 and 5 seconds respectively for paints A and B. Pilot ignition is that brought about by direct contact of the flammable material with a separate flame, as opposed to spontaneous ignition, which takes place when flaming is initiated by the interaction of the hot vapors from the decomposing tire with the oxygen in the air.

CONCLUSIONS

The measures suggested here should not be expensive to carry out. They should greatly increase the safety of a vehicle and its attendant firefighters and at the same time the vehicle's operational efficiency should also be improved.

BACKPACK MIST BLOWER FOR FIRE SUPPRESSION

Owen L. Lashley
District Ranger, Remer District, Chippewa National Forest

A backpack mist blower was used on the Remer Ranger District, Chippewa National Forest, during the spring fire season of 1962 (fig. 1). The unit was used in brush and slash areas and on running fires in hardwood leaves. Results, on the whole, were good when the machine was used alone or in conjunction with other tools. It was found that when the machine was used in dry, heavy, densely packed grass fuels, it was a great help in knocking the flames down and cooling the surface so that water from the backpack pumps could be pumped directly on the hot fuel underneath the matted surface. Use of a wetting agent increased the effectiveness of the mist a great deal.

The machine held enough water to spray continuously for a period of 8 to 10 minutes. This can be extended by running the motor at the slowest possible speed which, incidentally, is the best speed under most conditions. A man carrying a 5-gallon backpack can was assigned to carry water for replenishing the supply in the machine.

The size of the crew varied from four to six men depending on conditions. Crew organization was as follows: One man to operate the mist blower; one man to carry water for the mist blower; one man with backpack pump; two or three men with firefighting flaps, rakes, or shovels. Organization of the crew and location of the tools in the line were determined by the nature of the fire.

Figure 1.—A backpack mist blower being carried by a forest worker.

NEW 105-GALLON HELITANK

ROBERT C. SINGLETON
Public Information, Los Angeles County

A radically new type tank for dropping fire retardant chemicals or water from a helicopter was recently demonstrated by the Los Angeles County Fire Department at its Fire Combat Training Center. Fire officials from throughout the area who witnessed the demonstration were very enthusiastic and many stated that this new tank would drastically change helicopter air attack operations.

"The tank," Los Angeles County Fire Chief Keith E. Klinger says, "doubles and in many cases triples a helicopter's chemical carrying capacity as compared to rubber and plastic bags which were formerly used." The new all-metal tank holds 105 gallons, three times the capacity of the old 35-gallon bag (figs. 1 and 2). The new tank also is safer and more accurate, according to Chief Klinger and Roland Barton, the Department's helicopter pilot. Barton stated that the tank does not affect the helicopter's stability.

One of the 50-pound metal tanks can be installed or removed by two men in 2 minutes. The rectangular tank, which is fitted with interior baffles, is clamped to the fore and aft cross tubes of the helicopter at the four saddle points. Doors of the tank can be

FIGURE 1.—Helicopter loading 1000-gallon portable water reservoir by using 105-gallon drop tank.

operated electrically or manually. Manual control is mounted next to the pilot's left hand by the collective pitch control. Electrically, the doors are opened by the pilot pressing the cyclic stick button. To close the doors the cyclic stick trigger is used.

The tank was developed by the Research Section of the Los Angeles County Fire Department, under Captain Frank Hamp and Pilot Roland Barton. "Additional information may be obtained," Chief Klinger said, "by writing the Los Angeles County Fire Department, P.O. Box 3009, Terminal Annex, Los Angeles 54, California. The cost at the present time is approximately $1,200, but this is a variable factor."

FIGURE 2.—Helicopter dropping 105 gallons of water at Los Angeles County Fire Department Training Center.

AN IMPROVED FIRE PLOTTING BOARD

ROBERT L. BJORNSEN
Fire Staff, Gifford Pinchot National Forest

A plotting board is an essential tool in locating fires from azimuths reported by lookouts. Over the years a number of plotting boards have been developed for use by forest fire protection agencies. On such a board the retracting string with azimuth circle makes plotting forest fire locations accurate and fast. The Gifford Pinchot National Forest uses an adaptation of the retractable string-magnet-azimuth circle board (figs. 1 and 2). In addition to plotting fires on the board, the dispatcher can write temporary notes on the plastic cover protecting the map and azimuth circles with a grease pencil. The fact that descriptive notes can be made on the map can be very useful, especially when a lightning "bust" results in a large number of fires being reported in a short period of time.

Following is the procedure for assembling the plotting and dispatching board:

1. Construct backing frame using flathead wood screws and glue all joints. Bottom of the frame should be several inches wider than the top.

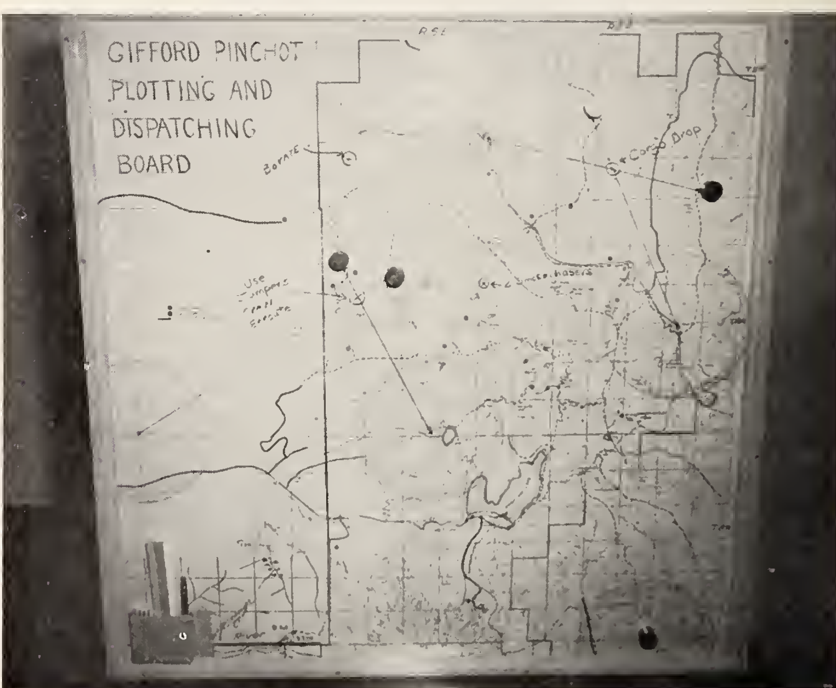

FIGURE 1.—Retractable strings extended from lookouts, illustrating cross-shot method of locating fires. Note temporary dispatch notes in grease pencil.

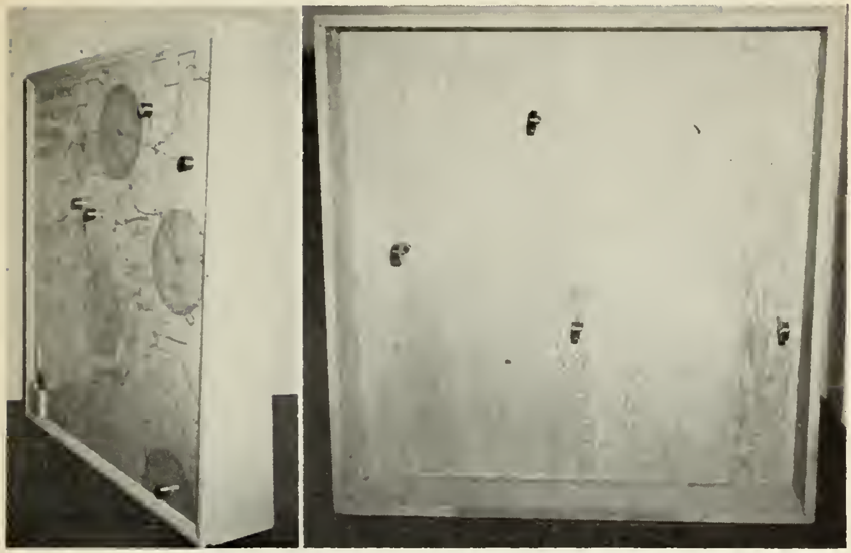

FIGURE 2.—Side view showing beveled bottom of frame and back view showing retractable string steel mounting. Back should be left open for servicing.

2. Affix plywood to backing frame. Use flathead wood screws and glue all joints.
3. Attach sheet iron to plywood using contact cement. Apply adhesive to both surfaces. Note: Use temporary spacers between plywood and iron until centered, then remove spacers from center toward edges. Once two surfaces touch, further adjustment is extremely difficult.
4. Wallpaper map to sheet iron using regular wallpaper paste and brush. Small wrinkles will flatten out when dry.
5. When dry, affix azimuth circles to map. Drill holes through lookout location to receive retractable map reel.
6. Attach plastic sheet to map using wood molding or aluminum counter edge molding.
7. Attach retractable map reels. Wooden spacers will be needed on the back to take up the slack. Leave back of plotting board open for servicing map reels.
8. Attach eyebolts to top of frame for hanging on wall hooks.

The magnets used are permanent type and guaranteed as such by the manufacturer. Orders should specify that 1/32-inch eye be slaughtered (not soldered) flush to bottom of magnet.

Materials List [1]

Item	*Cost*
Magnet, T811 with 1/32-inch dia. eye slaughtered flush to bottom; in quantities of 5 or more	$5.00
Reel, retracting string	4.15
Azimuth circle, 8-inch, red, size B	1.30
Subtotal, each lookout on board	10.45
Cement, contact, 1 pint	1.25
Plastic, clear 10 mil., $0.41/sq. ft., average size 25 sq. ft.	10.25
Sheet iron, galv. 24 ga., $0.28/sq. ft., average size 25 sq. ft.	7.00
Plywood, ⅜-inch, interior AA, 4 by 8 feet	4.75
Molding, aluminum angle, $0.20/linear ft., average size 20 linear feet	4.00
Misc., hardware and 1 pc. 1-inch select S4S pine	4.00
Map, planimetric blue line, 2 inches = 1 mile (including preparation of negative)	20.00
Subtotal	51.25
Average cost of materials per lookout $= \dfrac{51.25 + (10.45 \times 4)}{4}$	23.26

[1] Based on 5-ft. by 5-ft. plotting board with four lookouts. Labor costs to construct not included.

FIRE INVESTIGATION TRAINING AID

RAYMOND HIGGINS, *Fire Prevention Officer*, and
GEORGE BERDAN, *Assistant Law Enforcement Coordinator*,
California Division of Forestry

This poster has been developed as a training aid as well as for posting in fire control stations where the "Fire Investigation Hints," would be a constant reminder to officers and crews. Size is 2 by 3 feet; colors, black and white with shading. Art work was done by inmates of the California Medical Facility and printed by the State Printer. Total costs are approximately 10 cents per poster. It is planned to interject new ideas into a similar design each year and possibly to produce the poster in multicolor by silk screen process at one of the State prison facilities.

THE TRACTOR-CABLE METHOD OF PREPARING AREAS FOR BURNING

BYRON BALDWIN and JOHN E. WILSON
Lolo National Forest

The tractor-cable method of preparing logged-over areas for burning was adapted for use on the Lolo National Forest during 1960 and has proved to be more economical and efficient than any other method used in this Region. The condition of some stands of timber, which are diseased or stagnated or contain undesirable species, makes it necessary to harvest by clearcutting. After all the merchantable timber has been removed, tractors and cables are used to uproot the residual stand in preparation for burning and subsequent reforestation. While this method is not new, we believe the way in which it is applied is different.

The cable method was initiated on the Missoula District because of the need for clearing a residual stand on slopes that were nonoperable by mechanical methods (fig. 1). Two of these methods, tractor bunching and tractor pushover (trampling), are limited to slopes of 35 percent or less. The cable method has

FIGURE 1.—Two lower terraces cleared with tractor-cable.

been used successfully on slopes ranging from level to 70 percent. Although maximum slope limitation has not been determined, it is safe to assume that this method will function on any slope where there is a usable road.

Substantial savings have resulted from the use of the cable method over a 2-year period. Costs per acre prepared should continue to decrease as the original investment is amortized and refinements are made as a result of additional experience. This type of work has been done on three ranger districts and five different areas, involving a total of 815 acres. Costs ranged from $3.84 to $25.77 per acre, and average cost on all projects was $16.96. During the same period, average costs per acre for other methods of preparation were as follows:

	Average cost per acre	
Method	*Forest*	*Region*
Tractor trampling (walkdown)	$20.82	$22.41
Tractor bunching and piling	34.00	32.51
Hand felling	32.66	—

The cost on the 815 acres done by cable was approximately $3,260 less than it would have been had the next most economical method been used. Actually, the saving was greater since an even more expensive method would have had to be applied to the nonoperable slopes.

A private owner, as a result of observing this operation, used the method on some of his lands during 1961, and the State of Montana Forestry Department has obtained equipment for use in 1962. Several industrial concerns are interested in the potential of the cable method and the possibility of large-scale manufacture of the equipment.

Application of Method

General

The cable method is best adapted for use on fairly large areas that must be cleared of all the residual stand. Two tractors are required and should be of a size comparable to the D-6 or larger. Three-quarter-inch cable is made up into 100-foot sections, and the end of each section is fitted with a pressed-on ferrule which in turn is inserted into one end of a specially made connector (fig. 2). The cable sections and connectors provide for the following:

FIGURE 2.—Tractor connector, *left*; cable connector, *right*.

1. Ease of handling by crew members.
2. Increasing or decreasing the cable length as needed.
3. Disconnection for bypassing seed trees, seed-tree groups, or obstructions such as rock outcrops and large snags.
4. Swivel action necessary to prevent kinking of the cable.

On slopes greater than 35 percent, the tractors need some form of road from which to operate. The type of road system left on an area by the jammer method of logging lends itself readily to cabling. Also the tractors can operate from firebreaks that were constructed earlier for a prescribed burn.

Soil moisture conditions are important to the success of cabling. When adequate soil moisture is present, the trees can be easily uprooted and only a few small ones will be left. Some handwork may be necessary if the fuel created through logging and cabling is insufficient to scorch out the scattered small trees that remain standing. The damage to roads and the amount of debris on them are considerably less than that created by other methods of tractor preparation.

Equipment and Personnel Required:

- 2 tractors of a size comparable to a D-6 or larger, in good working condition and equipped with canopies.
- Approximately 600 feet of $\frac{3}{4}$-inch steel-core cable in 100-foot sections with ferrules pressed into each end.
- 12 straps for binding coiled sections of cable or cable reel.
- 2 tractor connectors and 5 cable connectors (fig. 2). (It is desirable to have one extra connector of each type for a spare.)
- Signaling equipment: athletic-type whistles and signal paddles. (The signal paddles resemble large table tennis paddles and are faced with highly visible material.) Lightweight, two-way radios would supplement or take the place of the whistles and paddles.
- Foreman (generally functions as a signalman).
- 2 to 3 crewmen (depending upon conditions).
- 2 experienced tractor operators.

Operating Procedure

Lay out the required number of cable sections and connectors. It is desirable to connect sufficient cable to permit a large loop to the rear of the tractors. This allows a relatively straight pull and eliminates the necessity of adding cable when the distance between tractors increases slightly.

Maneuver the tractors into starting positions. Generally the lower tractor operates slightly ahead of the upper one. This allows the cable the best chance of sliding up the side of a stump when encountered. It also reduces the hazard of rolling rocks dislodged by the upper tractor. Under some conditions, it may be necessary for the upper tractor to operate even with or ahead of the lower one.

Position the signalmen and cablemen to rear of the tractors. Signalmen must be visible to operators at all times and intervisible when possible.

The cableman's job is mainly to lift the cable over obstructions or disconnect it to bypass them. Most hangups occur on the backslope of the lower road and shoulder of upper one. Between these points the cable rides high enough on the uprooted trees and debris to clear stumps or other low obstructions. The cable should not be approached or handled until the tension on it has been relieved.

In summary, the potential of the tractor-cable method may be far reaching because of the efficiency and economy of the method. However, this method, like any other, has its limitations, and anyone contemplating its use should become familiar with them. For example, its use may influence the layout of sale areas or the retention of seed trees. The tractor-cable method will undoubtedly be improved as we gain more experience with it.

DIDYMIUM GLASSES FOR SMOKE DETECTION

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Forest Research Branch, Department of Forestry, Canada

Although there have been tales of lookout men with weak eyesight, good vision is a prime requirement for the position. However, an observer cannot report a smoke he cannot see and even with the best of vision it is difficult to recognize a light smoke against a light sky background, especially if atmospheric haze is present.

Glasses with didymium lenses, the type used by glass blowers, were reported to improve the outline of smoke and clouds on a misty day. These have pale blue lenses that absorb portions of the yellow and red sections of the spectrum. A pair of these glasses was tested by Department of Forestry staff at the Petawawa Forest Experiment Station, Chalk River, Ontario, during the 1960 and 1961 fire seasons.

Individuals in any group of people may have different reactions to the use of colored lenses; one may note an improvement while another will feel there is no betterment with the same type of lens under identical conditions. Thus the rating of the glasses is necessarily based on a somewhat subjective judgment.

Throughout this test, ratings were made on a comparative basis by observers viewing from a fixed observation point with and without glasses. Observers tried the glasses during the 2-year period and observations were made during a variety of weather conditions. Each observer recorded on a printed form the most distant landmark he could distinguish without glasses, the meteorological conditions, and the date and time of observation. Then ratings "yes" or "no" were made for the improvement in visibility of light and dark smokes, cloud outlines, and distance. Fortunately there were several fairly consistent sources of smoke in the area enabling the observer to make a rating on smoke for most sets of observations. On some occasions additional observations were recorded in which a pair of ordinary sunglasses with green-colored lenses were also tested.

Reports show an improvement in smoke recognition on slightly more than half the times the glasses with didymium lenses were used. When atmospheric conditions were clear, or only slightly hazy, light-colored smoke seemed easier to recognize with the glasses. When pronounced haze or mist was present, an improvement in both light and dark smoke identification was noted. However, on those occasions when ordinary sunglasses were tried, the observers felt they were equally effective. Thus, though it seems desirable for observers to have some form of light-filtering glasses, the selection of a particular type could be a matter of personal choice.

One interesting improvement in visibility was noted during an observation when heavy ground fog was present near the observation point; when the observer looked without glasses in a direction toward the sun, no detail could be seen in the shadow areas. Using the ordinary sunglasses, he could make out the outline of a roadside sign about one-eighth mile away in the shadow of a hill and could distinguish a tractor working beyond the sign. When the didymium glasses were used, it was possible to see and read the road direction sign and to recognize detail on the tractor. This improvement in visibility, if substantiated by aerial tests, might be of interest to pilots attempting water dropping in smoke-covered areas.

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[Jan., pp. 1–45; Apr., pp. 47–68; July, pp. 69–94; Oct., pp. 95–123.]

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustrations. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproductions. Please therefore submit well-drawn tracings instead of prints.


Smokey says:
SMOKEY
BE SURE
it's DEAD OUT

766FI

FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

VOL. 23 NO. 3
JULY 1962

Forest Service
UNITED STATES DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Growth Through Agricultural Progress

Volume 23 Number 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (October 17, 1958).

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Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1962

CONTENTS

Mention of specific products in this publication is necessary to report factually on available data. Use of the names does not imply endorsement by the Department over similar products not named.

HELICOPTER FLIGHT DATA ARE EASY TO USE

HERBERT J. SHIELDS
Mechanical Engineer, Arcadia Equipment Development Center, Arcadia, California

Would you like to know the limitations of load, altitude, and takeoff distance of the next helicopter you hire? This is not as difficult as it may seem now that reliable tests have been conducted.

We have now concluded two tests under a joint program with the Army Aviation Test Office at Edwards Air Force Base and have published reports on the Bell 47G-3 and the Hiller 12E 61. Results will soon be available on the Bell 47G-3b. You can use this information in training, planning payloads, and improving safety. Pilots may use it as good basic material for operating in the mountains.

We have put much of the information into chart form. Before you let the appearance of the charts stump you, however, let's discuss a few basic concepts of how they are set up and why they work.

Hovering performance.—In most of our work in the mountains the ability to hover and lift reasonable loads while in a hover is the most useful characteristic. Since the rotor blades must move a mass of air equivalent to weight lifted, this performance is directly related to the power available from the engine.

Engine power is dependent on atmospheric pressure and temperature, which can sometimes be artificially controlled by supercharging, or "derating;" that is, only allowing use of partial power at low altitude and gradually drawing more reserve as the ship goes up until engine limits are reached.

At any power setting by the pilot, such as full power, the helicopter can lift a greater load when hovering with the skids 5 feet above the ground than it can lift with the skids at 50 feet, because of "ground effect." This effect gradually diminishes up to 20-50 feet depending upon the helicopter used.

Now, let's take a look at curve 1 (fig. 1). The top position shows a scale of temperatures, while at the left, altitudes are marked off. The lines actually indicate engine power limits for the various combinations of temperature and altitude. The warmer it gets, the less engine power is available.

Assuming an operating altitude of 9,000 feet, and a temperature of 25°C. (77°F.), we start at the 9,000-foot point on the altitude scale and go to the right until we reach the 25°C. point (1 circled), then draw a line straight down until we visually follow in between the short curves at the bottom. The helicopter can

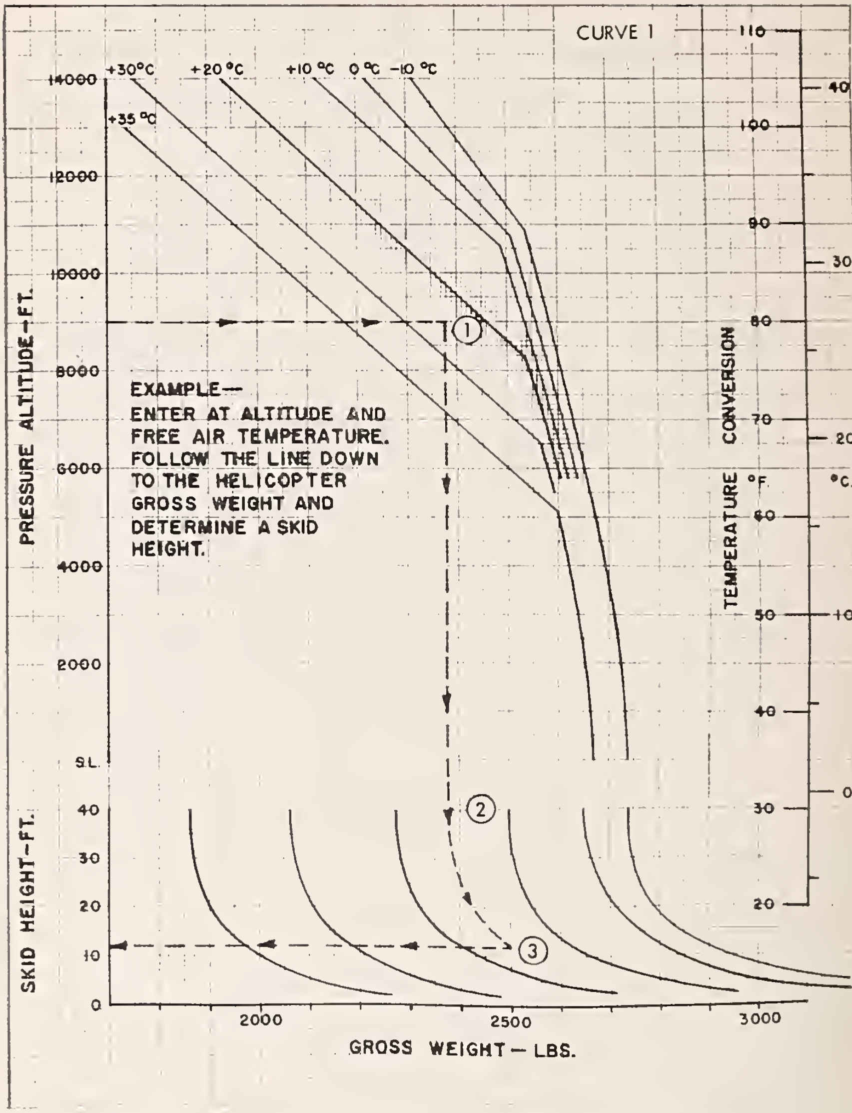

FIGURE 1.—Hovering performance, Bell Model 47G-3 (N6783D).

perform anywhere within the area to the left of this imaginary line.

If the hover condition must be 40 feet or more, *drop straight down* from point 2 (circled) to the gross weight line and read 2,380 pounds. If you only need to hover at 12 feet, follow along the curves to point 3 (circled) and then down to read 2,500 pounds. Similarly, for a 5-foot hover, read 2,650 pounds.

Now let's work backwards and see what happens. Let's say we have to hover at 15 feet in order to hook up some cargo that weighs 500 pounds. Assume the helicopter, fuel, pilot, etc. weigh 1,900 pounds. This gives us a gross weight of 2,400 pounds. Starting at 2,400 pounds and moving straight up to the 15-foot level, we then follow the reverse procedure until the 40-foot line is reached, then go straight up. We could hover at 15 feet at 10,000 feet at 22°C., or at 6,000 feet, out of ground effect (OGE). If we remove 100 pounds we can hover at 11,000 feet at the same temperature, or we can add 100 pounds and hover at 9,200 feet.

These values were obtained from tests conducted in *zero wind*, and therefore are conservative for most cases. Tests show that even 4 or 5 knots of wind can improve performance data, particularly under marginal conditions.

To keep from getting lost on this curve, just remember—adding weight decreases hovering performance or altitude.

Takeoff performance.—In cases just shown where the helicopter cannot hover more than a few feet off the ground, a takeoff can still be made. However, some distance must be covered parallel to the ground to accelerate to enough speed to climbout. This is normally the safest takeoff procedure even when a "straight up" takeoff could be made.

Takeoff performance is commonly expressed in terms of distances to clear a 50-foot obstacle. This distance includes both the acceleration and climbout runs. The length of run depends on several variables: piloting technique, weight, temperature, altitude, and air speed selected for climbout.

Now, notice that weight, temperature, and altitude also directly affect the hovering performance which we discussed. By making takeoff tests at various weights and speeds, the data can be prepared into various "nondimensional" factors so that the hovering and takeoff performance can be directly plotted as shown on curve 2 (fig. 2). In other words, our engine power also directly affects the takeoff distance.

Let's look at curve 2 more closely. On the curves at the right are noted "skid height" values. These are *hovering capability* values regardless of all other factors. One way of finding this value would be to bring the helicopter to a hover using *full power* and estimate skid height to the ground. Let's say you come up with 12 feet. If you decide to climbout at 30 knots, follow the 12-foot line from point 1 to point 2 and read across. You will need 280 feet to clear a 50-foot obstacle. You don't have to takeoff from 12 feet, but from a normal 2 feet or so, since we were only determining the capability for entry into the curve.

Another way of finding this value would be from the skid height obtained from curve 1 after knowing temperature, altitude, and gross weight. Again, you could work backwards to find your safe load if you have only a small takeoff space.

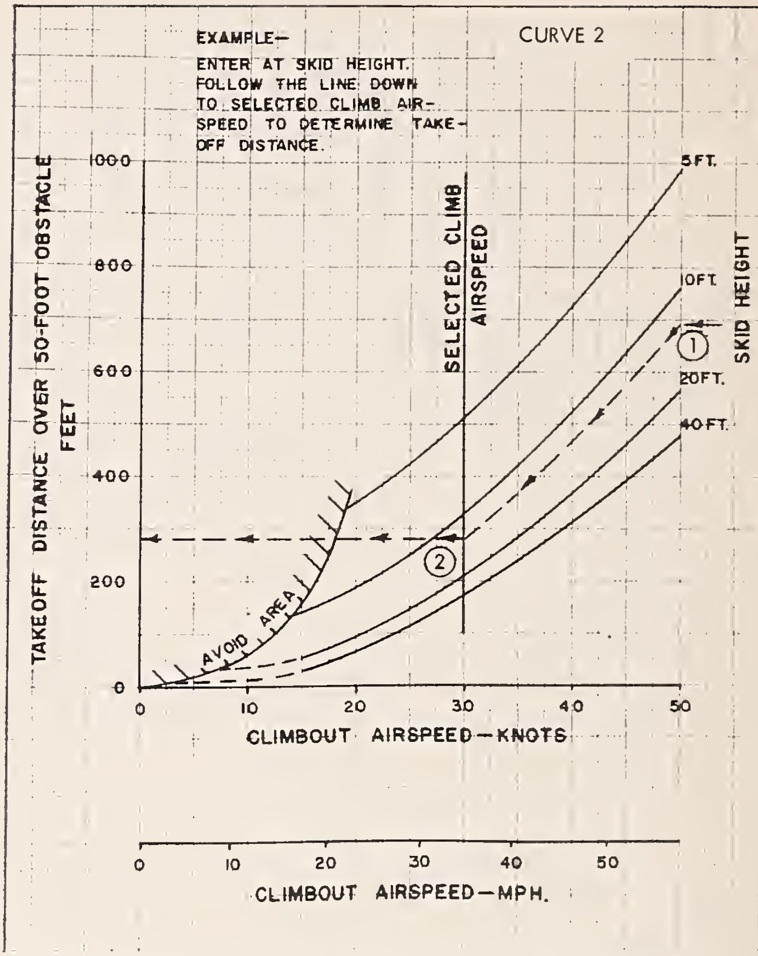

FIGURE 2.—Takeoff performance, Bell Model 47G-3 (N6783D).

Summary.—Curve 1 gives an overall picture of hovering performance by tying together altitude, temperature, and helicopter gross weight. Curve 2 shows takeoff run required at various hovering performance values for usable climbout speeds. Tables prepared from the same data used in constructing the curves are available in existing reports on the Hiller 12E/61 and Bell 47G-3. However, once you have mastered the curves you will find them giving you a more useful picture of performance.

DEHAVILAND BEAVER WATERDROPPING TESTS

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Lake States Forest Experiment Station

Aircraft are important tools in the management and protection of the Superior National Forest in northern Minnesota. This is particularly true in fire detection and suppression activities. Float-equipped aircraft figure more prominently each year in handling these vital jobs.

In line with this increased use has been an equipment development program headquartered at Ely, Minn. Work here has been directed toward the development of equipment and techniques for increasing the effectiveness of waterdropping on going fires. Testing of this equipment has been under the general supervision of the Ely Service Center. The Lake States Forest Experiment Station has cooperated by providing assistance in design and analysis of waterdrop experiments.

Calibration tests conducted at Ely in June 1959 were summarized in *Fire Control Notes*, July 1961.[1] During each flight a DeHaviland Beaver dropped 125 gallons of water over a prescribed target area. Water concentrations and drop patterns were recorded.

On the basis of the 1959 tests, the water tank and release gates on the Beaver aircraft were modified and the tests were repeated in July 1961 (fig. 1). This report will show that the design changes produced marked improvement in waterdropping characteristics as compared to the 1959 test. It also will provide a comparison of these latest results to those obtained in a California experiment, conducted 1955-59.[2]

Test Conditions and Equipment

The 1961 tests were conducted over level, open ground at the Ely airport, using essentially the same procedures as in the 1959 tests. The airport site provided a convenient location for a network of cups in the target area to catch water for drop calibration purposes.

Only plain water was used during the 1961 tests, while both plain water and "wet" water were used in 1959.

Both morning and afternoon drops were made. The temperature averaged in the low 70's, relative humidity varied between 64

[1]Strothmann, R. O., and McDonald, L. J. Water-bombing with the DeHaviland Beaver. U.S. Forest Serv. Fire Control Notes 22 (3): 93-95. 1961.

[2]Davis, James. Air drop tests, Willows, Santa Ana, Ramona, 1955-59. Calif. Div. Forestry.

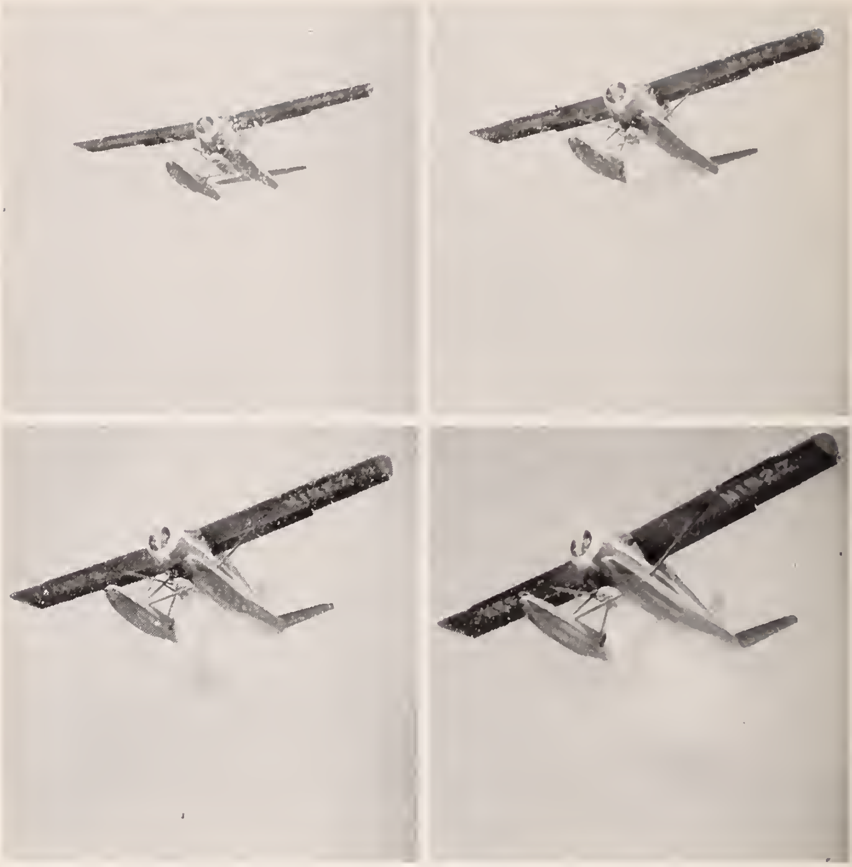

FIGURE 1.—Sequence of a test waterdrop from a DeHaviland Beaver aircraft.

and 89 percent, and the winds were generally from the southeast averaging 4 to 6 m.p.h. Three drops were made during perfectly calm wind conditions.

Airspeed averaged 80 m.p.h. Drop altitude averaged 100 feet, although one load was released at a height of 150 feet. Accuracy was excellent. Only two of the 14 drops partially missed the target area.

Ten drops were made on a grid system identical to that of the 1959 tests. Distance between cups along the 500-foot length of the grid was 50 feet. Along the 100-foot width of the grid, cups were spaced at 10 feet.

On the third day of testing, the grid length was reduced to 250 feet—one-half the original length—when it became evident that only a small portion of the 500-foot grid was being utilized. The grid width remained the same. This more compact pattern arrangement made it possible to plot the waterdrop concentration contours more accurately.

Design changes were made in the tank, pickup tube, and release opening. In 1959 a fuselage tank was used with a snorkel tube extending into the water beneath the plane. This arrangement was inconvenient, and in 1961 the fuselage tanks were replaced by streamlined exterior tanks, mounted below the fuselage and between the pontoons (fig. 2). These tanks were modified surplus wingtip fuel tanks cut down to hold 125 gallons of water. The snorkel tube was also redesigned for the 1961 tests.

The most important changes were made in the drop openings. The three openings on the 1961 model total 754 square inches, compared to only 225 square inches of opening on the tank tested in 1959. According to Arcadia Equipment Development Center standards, 500 square inches is satisfactory. The same volume of water (125 gallons) is now released through three gates that total three times as large as the drop openings in the 1959 equipment. This larger opening allows a sudden rush of water to be cascaded from the tank (fig. 3), eliminating the slow, extended release of water characterized by the smaller tank opening.

Results

Contour maps were constructed for each drop to show the water concentration and pattern. Iso-lines were drawn indicating areas having water concentrations equal to or in excess of 0.4 gallon per 100 square feet. The square-foot area within each contour was determined and averages were computed. The results are summarized in table 1.

FIGURE 2.—New water tank assembly on Beaver aircraft has three release openings and modified snorkel tube for filling tank.

FIGURE 3.—Water cascades freely from enlarged gates in the redesigned 125-gallon tank.

TABLE 1.—*Area covered and concentrations in three tests*

Item	Beaver tests		California Stearman
	1959	1961	
Average *total* pattern length—feet	400	211	(1)
Average *effective* pattern (over 0.4 gal. water per 100 sq. ft.):			
Length—feet	150	157	202
Width—feet	45	61	(1)
Average total coverage for:			
0.4-0.5 gal./100 sq. ft.—square feet	4,086	5,802	6,530
1 gal./100 sq. ft.—square feet	400	2,198	3,100
2 gals./100 sq. ft.—square feet	0	507	94
Average maximum concentration per 100 sq. ft. at pattern center[2]—gallons	0.9	3.3	(1)

[1]No record.

[2]Average maximum amount of water measured in any one cup in the pattern.

1. The *average total pattern length* for the 1961 tests was about half the average length recorded in 1959. This is an improvement because now more water is concentrated into a smaller area, making each gallon more effective.

2. The *average effective pattern length* proved to be about the same for both years, while that of the California Stearman air-

craft was about 33 percent longer. The 1961 effective pattern *width* was about 30 percent wider than that of 1959.

3. *Surface area covered* and *average concentrations* were the most significant improvements noted. In concentrations of 0.4-0.5 gallon per 100 square feet, the Beaver covered an average of 1,700 square feet more per drop in 1961 than it did in 1959.

The biggest improvement came in the total area covered by 1 gallon of water per 100 square feet. In 1961 this coverage was five times as large as it was in the 1959 tests; it was only slightly smaller (900 square feet average) than the area covered by the Stearman.

4. Results of the 1961 Beaver tests were superior to both the 1959 tests and the Stearman tests in area covered by a concentration of 2 gallons per 100 square feet. The Beaver tests in 1959 *never* attained this concentration during any of the 15 drops using plain water. The Stearman tests averaged 94 square feet coverage at this concentration, compared to the Beaver's 507 square feet coverage recorded in the 1961 tests.

Water-bombing with the DeHaviland Beaver in the Superior National Forest lake country has already proved successful as a supplementary fire suppression measure. The present tank and drop opening equipment allows a sufficient volume of water to reach the ground to be effective in knocking down small fires or cooling hot spots on large fires. The waterdrop is now considered to be a routine fire suppression measure on the Forest. Properly equipped airplanes are available throughout the fire season—ready to take off at any time on a suppression mission.

HAZARDS TO GROUND PERSONNEL FROM AIR DROPS OF FIRE RETARDANTS

Arcadia Equipment Development Center
Arcadia, California

In June 1960, tests were conducted in an effort to obtain data that would establish hazards and defense procedures against the dangers of direct drops on personnel from air tankers. Five different air tankers were used—TBM, N3N, F7F, SNB, and Vega—to obtain differences from capacities and tank design. Direct water drops were made on an instrumented dummy. Our dummy, "Sierra Sam," equivalent in stature and build to a husky man, was equipped with accelerometers inside his chest.

The dummy was placed in a standing position for drops at decreasing increments of altitude until significant damage was evident. Drops were then made on the dummy in the prone position. This procedure was followed for each of the five air tankers (fig. 1).

FIGURE 1.—TBM dropping 600 gallons. Height 35-44 feet, speed 150 knots. Dummy lower center at moment of impact.

FIGURE 2.—Dummy after being knocked from standing position.

After the first several drops were made, it was obvious that a major portion of the hazard occurred when the dummy struck the ground after being hit with the water. When he was knocked from the standing position, high values of "g" loading were obtained in some cases just from falling down (fig. 2).

When dummy was lying down, he was carried with the liquid on very low drops and thrown to the ground. In other words, it wasn't the fall that hurt, it was the "sudden stop at the end."

The hazard is reduced when the body is in the prone position. It was difficult to obtain much body movement with a drop from above 15 feet. Below this height a veritable wall of water carries the body easily. A hardhat on the dummy, with the chin strap fastened, usually remained in place and afforded good head protection.

On some drops it was observed that a considerable amount of loose ground debris was picked up with the liquid and carried along. For this reason a prone position with the head forward and protected is recommended. If the person can grasp something firmly imbedded and hang on, any movement that can be prevented will help. Handtools, obviously, also present a hazard; therefore, they should be placed at one side.

It is difficult to evaluate injury potential to a human from acceleration figures. The nature of the obstruction against which the victim is hurled and the posture at time of contact are of greater significance. It is like comparing the injury of one who is fatally hurt after slipping on a sidewalk to that of another who survives a two-story fall from a building. Nevertheless, the results showed a deadly potential. On several drops it was noted that definite skull damage occurred, and on one drop the left arm and shoulder were torn completely free.

Conclusions

1. Drops from air tankers of any capacity are hazardous. The tankers used for test all showed that under some conditions a drop on a human can be deadly.

2. Size of load does not appear to be a major factor in initial impact forces on a human, although accuracy of a drop of large size does not need to be as exact as one of small size to obtain a hit.

3. When a human is standing, drops are dangerous at heights under 50 feet. When a human is prone the hazard is reduced and he is probably safe if drop is from a height above 20 feet. The greatest injuries appeared to be caused by the final impact with the ground after a human is carried or thrown by the liquid.

4. The dangerous target area was small, particularly lateral to the drop direction. On some drops a hazard existed from loose debris being picked up and thrown with the liquid.

5. Fatal injuries can be minimized by following these rules:
   a. Lie down facing aircraft, with hardhat in place.
   b. Place handtools off to side.
   c. Grasp something firm to prevent being carried with liquid.
   d. Do not run unless obvious escape is assured.
   e. If in timber stay clear of dead snags, tops, and limbs in drop area. Material such as rocks, live and dead growth, and rolling material on slopes are particularly hazardous.

THE PLACE OF THE FIRE BEHAVIOR OFFICER IN THE FIRE SUPPRESSION ORGANIZATION

KEITH K. KNUTSON
Staff Officer, Division of Recreation & Lands, Rocky Mountain Region

The fire behavior officer on project fires has two primary functions; first, as a forecaster of probable fire behavior for information of the fire boss in making suppression plans, and second, as an aid in assuring safety of personnel from action of the fire. From experience gained during the 1961 fire season, a third probable responsibility has become apparent; working in close cooperation with line overhead to reassure them of fire behavior conditions currently and continuously.

On a recent western project fire, it was observed that line overhead from division boss through the crew boss were sometimes reluctant to make vigorous attack. This reluctance was attributed to the potential blowup characteristics of a fire in heavy fuels which were critically dry, and the inability of line overhead to properly forecast behavior of the fire. The attitude of the overhead was reflected in crew effort and effectiveness of fireline production at critical points and posed a major problem in the control of this fire. Some of the reasons for this reaction, which was exhibited by personnel trained under widely varying geographical conditions, were felt to be as follows:

1. Timber types. Heavy old-growth timber at the lower elevations, approximately 50,000 board feet per acre, restricted visibility to a very short distance.
2. Topography. Steep, rocky terrain made movement of individuals and crews slow and difficult.
3. Atmospheric conditions. Continued nighttime temperature inversions kept immediate fire area filled with smoke well into the active burning period, about 1100-1200 hours. This resulted in poor visibility, coupled with uncertainty of behavior of the fire.
4. Morale. Because of fatigue and repeated loss of suppression line, morale of some of the crews and overhead was low. Repeated fire runs of varying intensity and length caused apprehension and made the men overcautious. Alert and aggressive suppression action became difficult to obtain.
5. Much of the fireline was built well in advance of the fire. This made burning out necessary, and when it was not done promptly, the fire moved and usually crossed the firelines.
6. Fire behavior knowledge. In discussing behavior of this fire with fire suppression personnel, it became apparent that abbreviated types of fire behavior training tend to overstress danger

to personnel from fire action. When personnel safety is overstressed in training of inexperienced men, they do not have necessary background to evaluate the training, and as a result, they become timid and overcautious in face of unfamiliar fire behavior. This attitude further reduces the chance of aggressive attack on the fire.

Solving these problems became paramount in the control of this fire. An overhead meeting was held at which top fire management personnel explained the past and the expected future behavior of the fire, and its relation to personnel safety and choice of tactics needed to safely effect control. This meeting did much to dissipate timidity and fear and to instill confidence. As a followup on this meeting, hourly fire behavior forecasts were made on the fire-net radio frequency to division and sector bosses. With uncertainty about behavior of the fire removed, all subsequent control action was markedly more aggressive. Line overhead said the forecasts were a big morale booster and crews looked forward to the hourly broadcasts.

As a result of this and other experiences during the 1961 fire season, it is felt two things are needed in order to improve effectiveness of fire suppression action.

First, the emphasis in fire behavior training must be shifted from a negative attitude which induces fear of fire. The positive approach will teach fire behavior as necessary knowledge which when properly evaluated will dictate proper tactics for fast aggressive safe control of the fire. In this way, personnel safety will appear in its true perspective.

Second, the fire behavior officer is a key man in the plans section. As a specialist in the factors that influence probabilities related to how this fire will burn in intensity and spread, he furnishes essential information for strategic and tactical planning.

It is important that the fire behavior officer be fully qualified as a line or division boss. Ready access to the fire boss, line boss, or other key line overhead on a critical portion of line will insure that important fire planning and personnel psychology aspects of fire behavior will be adequately evaluated in fire suppression strategy.

FIRE HOSE THREAD STANDARDIZATION IN THE U.S. FOREST SERVICE

Division of Fire Control, Washington, D. C.

Increasing emphasis on mutual aid in forest fire fighting between Federal, State, and other protection agencies make interchangeability of equipment highly desirable. Hose coupling problems have been serious on major forest fires in the United States. Lack of standard threads has resulted in fires escaping. On one fire two fatalities occurred because of interruption in water delivery due to lack of an adapter. From a civil defense standpoint standardization is highly important.

Fire hose adapters can provide some degree of interchangeability but they do not solve the basic problem. They are heavy and comparatively expensive, and too many are needed to assure full interchangeability of hose and related fittings.

The U.S. Forest Service has adopted the National Fire Protection Association standard fire hose thread for 1½-inch hose and is currently engaged in a 5-year conversion program.

Conversion work in the California Region started this year and is planned for completion by June 1963. Before starting the program they had a fairly complete inventory of thread units to be converted at each station. Because of the large number of units to be converted, it was decided to recut female threads and sleeve the male threads. Most of this work is contracted. Adapters were not used where threads could be recut or sleeves used. Adapters are used on male threads that cannot be machined, such as those on portable pumps and hydrants.

The California Region has developed information and a few guides which may be helpful to others planning similar programs. These are (1) inspect and test all hose prior to conversion, and replace obsolete hose with the new standard coupling; (2) make a complete inventory of job to be done at each station; (3) assign a qualified man to head up the program; (4) plan and budget for the job; (5) if the inventory of thread items is large, consider contracting. If the number of conversions to be made is low, it may be least expensive to use adapters or replace couplings. If desirable, female thread cutting machines may be rented, and male adapters used; or a thread shaving die and insert tool can be purchased to prepare male threads for sleeves. Sleeves may be purchased from fire equipment suppliers or thread conversion contractors. The thread shaving die costs about $117 and the special insert tool about $25.

STAINLESS STEEL HOSE PATCH

G. E. MacKinnon
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Ontario Department of Lands and Forests

The Department of Lands and Forests as well as the forest industries in Ontario have attempted for years to solve the problem of stopping leaks in fire hose during firefighting operations. To meet this need for an efficient method of stopping serious leakage from ruptured hose on the fireline, the stainless steel hose patch was engineered and perfected.

Testing commenced in 1957. A large variety of materials and designs were tested, including linen, various types of rubber, and finally the stainless steel patch. It was found in testing stainless steel ranging from 20 to 28 gauge that 20 and 22 gauge were too stiff, while 26 and 28 gauge did not have sufficient strength and opened up under pressure. The final patch selected was manufactured from 24-gauge stainless steel.

The patch is of sufficient size (5½ by 3½ inches) to cover all normal ruptures in 1½-inch fire hose (fig. 1). The locking device is very simple; the ends of the patch are folded over so that they snap together and lock securely in position when the patch is wrapped around the hose (fig. 2). This makes a smooth band of steel with no projections to catch while the hose is dragged across the ground.

To use the patch: (1) *Cut pressure.* This can be done by using a Siamese or by kinking the hose. Two men should work together, one cutting off the pressure and the other installing the patch. It is also possible for one man to install patches quickly and easily by using a "hose strangler" to shut off the water flow. (2) *Squeeze hose together* and crease lengthwise to reduce its diameter. This is not absolutely necessary but reducing the diameter makes it easier to close the patch. (3) *Slip patch over hose and lock in position* with the locking device on the opposite side of hose from the hole.

In 1959 the Department of Lands and Forests arranged for the manufacture of 3,000 stainless steel hose patches which were distributed throughout the twenty-two districts in the Province. In 1960 and 1961 additional patches were manufactured and distributed. These have been used with considerable success during the past three fire seasons. They are now considered essential and are carried as standard equipment in every fire pump toolbox. It is recommended that at least ten patches be carried in each toolbox to take care of all emergencies.

These patches have been used on lined and unlined linen 1½-inch hose with equal success, stopping the leak completely on holes up to 2 inches in length. The original tests were carried out using a Wajax Mark I pump running at ¾ speed with two

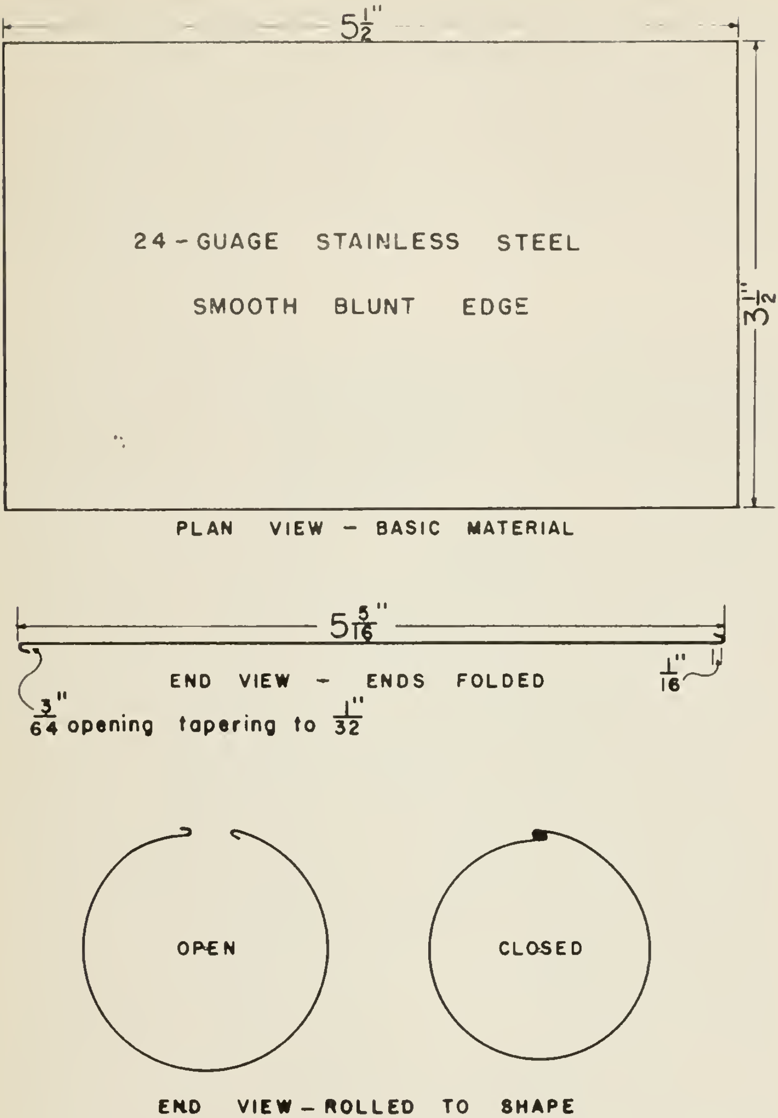

FIGURE 1.—Stainless steel hose patch.

lengths of hose to the nozzle, but in actual field conditions the patches have been used successfully with all makes of pumps, under all operating conditions.

Advantages of this patch are (1) simplicity of design, (2) light weight and small storage space required, (3) no special tools needed, (4) patch remains securely on hose with the pressure on or off and when hose is pulled over ground, (5) patches can be left on the hose to mark holes for repairing when brought in to the repair depot, (6) low cost, approximately $35 per hundred.

FIGURE 2.—Hose patch in open and closed position and installed on hose.

FIRE HOSE ROLLING MACHINE

WILLIAM C. FISCHER, *Forester*, and JAMES F. POTTER,
General Supply Clerk, Boise National Forest

A machine for rolling fire hose developed by James F. Potter of the Boise National Forest is designed for 1-, 1½-, and 2½-inch fire hose of 50- to 100-foot lengths. The resulting rolls are tighter, more round, and more easily handled and cargoed than rolls produced by hand rolling.

The machine includes a metal drum with two side disks, one of which is removable. The drum, attached to a shaft, is turned by a hand crank with a gear reduction drive of approximately a 2-1 ratio and is mounted on a metal stand supported by four tubular metal legs. The hose feeds on the drum through a metal trough and pressure rollers mounted on the front of the machine. This feature eliminates the time-consuming task of untwisting the hose prior to rolling (fig. 1).

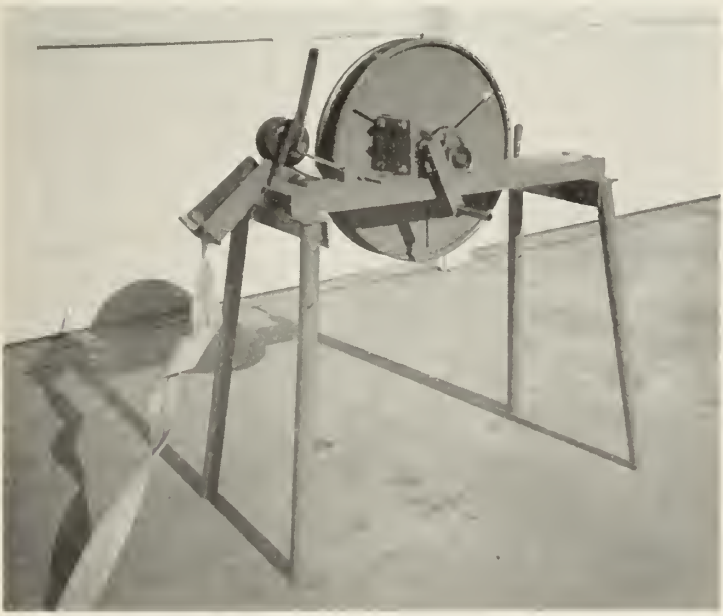

FIGURE 1.—Hose rolling machine showing gear reduction drive, hand crank, trough, and pressure rollers.

The removable disk is secured by latches while machine is in operation. Slots at the end of the drum allow hose to be tied before removal (fig. 2).

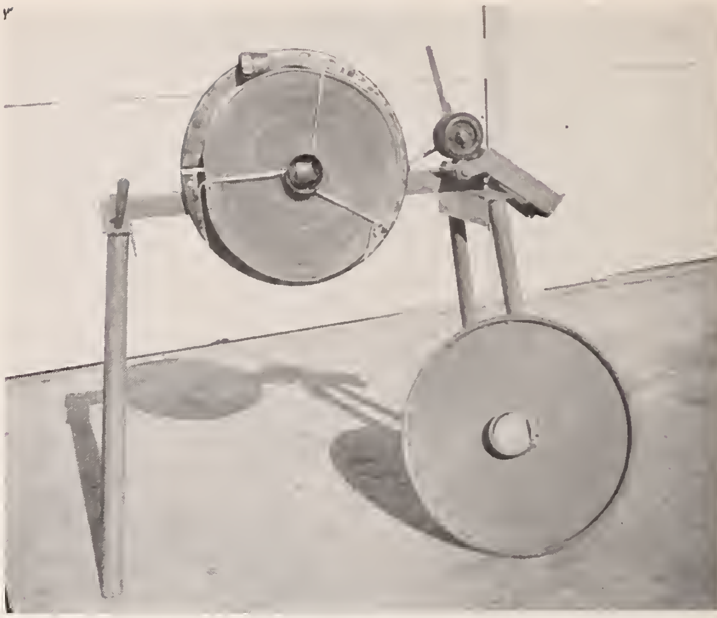

FIGURE 2.—Machine with disk removed and tied roll on drum.

The machine can be operated by one man, although it may be desirable for a second man to assist in laying out the hose. A 100-foot length of 1½-inch hose can be rolled, tied, and removed from the drum in 2 minutes. Compared to handrolling, the machine greatly expedites rolling hose returned from the fireline and makes it more quickly available for reissue on subsequent fires.

Planned modifications will make the machine more portable for shipping or cargoing purposes. Cost of the machine in its present form is approximately $160.

DEVELOPMENT OF AN ORGANIZED SUPPRESSION CREW PROGRAM

Sequoia National Forest

For many years it was possible to pick up agricultural workers in Porterville, Calif., for fire suppression work. These men were either citizens or legal aliens who lived permanently in Porterville. Since agricultural work is heaviest in the late fall and early spring, they were available on reasonably short notice for fire suppression work during the summer months. Prior to 1958 the maximum number mobilized at one time was about 75 men. In 1958 this number was increased some. The bad fire year in 1959 caused us to take a more active interest in this source of manpower.

These men, until 1959, had been recruited in mass with no thought toward a working organization, training, or crew stabilization. With the Southwest Indian crew organization as a guide and about 200 available local agricultural workers, mostly of Spanish-American extraction, we set out to improve the efficiency of these crews.

Many of these people do not speak English, or speak it poorly. This has lead to the development of "leaders," or "contractors," in their ranks. These leaders speak English and act as go-betweens, or intermediate agents between the ranchers and the laborers. Study of these people in action led us to two natural organizers.

We sat down with these men and discussed the problem of organization and training. We agreed to pay one man crew boss wages (the crew leader) for each 25 to 28 men, and one man squad boss wages for each 5 to 7 men. Each man in a crew was to receive a complete physical examination and 8 hours of training either on a fire or in planned training sessions. When a crew reached this status, a blue cooperator card was issued each crew member. The so-called organizers, who are really the key to the organization, are paid sector boss wages. They are responsible for qualifying crew leaders and squad bosses, discipline in the crews, welfare, organization, etc.

The crew leaders must all speak English. These men are not qualified Forest Service fire crew bosses, but it is intended that each crew leader will work with the crew boss and relay his directions to the men through the squad bosses. It is also the leader's responsibility to maintain the crew as a unit in fire camp and to direct its activity in the absence of the Forest Service crew boss. Many of these men could be qualified as fire crew bosses. We prefer to have them called *crew leaders* to distinguish them from fire crew bosses. The squad bosses are qualified Forest Service squad bosses for these crews.

Originally this program was developed as a source of followup manpower for fires on the Sequoia Forest. It was organized to the point where we could have 200 men on their way in 2 to 3 hours. In 1959 word got around and crews were requested for off-forest fires. Each time this occurred, interest was created in the surrounding area and additional crews were organized. At the present time we have 22 qualified crews of 26 men each. During the 1961 fire season, these crews were dispatched to 8 National Forests and 3 other protection agencies in California. They were employed on 20 major fires and numerous smaller fires. Man-employments were 6,986 with a total of 29,000 man-days worked.

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Map Azimuth Circles For Base Heliports

During periods of very high or extreme fire conditions on the Six Rivers National Forest helicopters are often contracted for fire standby on the ranger districts. Two to four specially trained men are provided by the district for use as a helitack crew. The helicopter, loaded with tools and equipment and ready for dispatching, stands by at a base heliport near the district headquarters.

Quite often the helicopter pilot is unfamiliar with the terrain in which he is to operate. If a fire call comes in, it may be necessary to brief the pilot with maps and directions before he can be dispatched. Sometimes the fire is located far from the base heliport in difficult, unfamiliar terrain. Valuable time may be lost in searching for the fire.

On the Mad River District we have speeded up helitack dispatching by using an azimuth circle placed on the dispatcher's map directly over our base heliport, exactly as is done for lookouts on the map. This azimuth circle should be offset east or west depending on the magnetic declination of the area involved. This is necessary, of course, because the helicopter is flown by magnetic bearing.

A retractable string reel allows the dispatcher to reel out the string directly over the bearing that the pilot should fly to the fire. The dispatcher may then merely give the pilot a flight bearing and distance from the base heliport to the fire or another helispot on the district. This simple use of the azimuth circle can, in many areas, simplify and speed up the helitack dispatching system.—John D. Dell, *Fire Control Officer, Mad River District, Six Rivers National Forest.*

"FIRE WATER" IN THE SOUTH AND A FIRE "HEAD BREAKER"

R. J. RIEBOLD
Forest Supervisor, Florida National Forests

Eighty some days of fall drought, drying swamps and bays, and the winter-spring fire season coming on are enough to start a southern fire control man thinking about "fire water," not fire water in the usual colloquial sense but water that plays a part in fire control.

Fires in the dry swamps are something to think about. The dry swamps are not plowable. The tractor-plows upon which all southern fire control men depend are useless once a fire gets off the pine land into the dry swamps. The obsolete 4-wheel-drive tankers most fire control organizations still have are almost as useless. Sometimes they can get to the edge of a swamp and sometimes their hundred feet of hose will reach the deep burning fire but usually with only a hundred gallons of water. Fire crews sometimes putter for days on dry swamp fires and sometimes a dry swamp fire breaks out days later and makes a new run across the pine land. Yet in the Coastal Plain there is an ocean of water within 30 feet of almost any fire. To get it, all you need is a hole in the ground and a pump.

When fire suppression wells were developed in Michigan in the 1930's they were discussed with interest in the South but actually met with no favor. Probably fire control men then had all they could do to deal with the thousands of fires on the pine lands. The dry years in the 1950's revived interest in suppression wells. Tests were made in South Carolina which were reported in Fire Control Notes by Devet and Fendley.[1] According to them the commercial well drillers are the best possible help on suppression wells. They can put down wells rapidly and cheaply. All that is needed is a list of well drillers in the surrounding counties and agreements as to availability and price.

Probably most fire control units have a few thousand feet of never used forestry hose and one or more gear pumps. The gear pumps are not for suppression wells. Shallow well water almost always contains so much suspended grit as to wear out a gear pump in a short time. There are rubber blade impeller pumps that will handle gritty water, and these can be purchased. If forestry hose could be concentrated in area depots, it could be airlifted to places where it is needed in quantities sufficient to do the job. Pumps could also be stocked in depots along with all accessories. With pumps putting out 50 gallons per minute from one or more

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[1]Devet, D. D., and Fendley, L. T. Underground sources of water for fire suppression. U.S. Forest Serv. Fire Control Notes 20(1):11-14, illus. 1959.

suppression wells, fires in dry swamps can simply be watered out. Nobody needs to use suppression wells on every fire; everybody could use them on dry swamp fires.

Drought can usher in severe surface fires even on pine lands. The usual practice of simply plowing around a fire is not quite adequate because of the frequent spotting over the plow line. Ever since World War II most fire control organizations have been without the crews of men needed to fire and hold lines in support of tractor-plows. Even when work crews are available they do not arrive at fires as soon as the plows do. This has led to practices designed to hold line without crews, such as double plowing, "loop plowing," and "doubling back" to catch breakovers. Even when there are 4-wheel-drive tank trucks they cannot follow the plows in many places. Consequently, fires are not as well fought as they could be.

The means for supporting the tractor-plow without a crew of men was developed about 1950 in the light tractor-tanker. Several kinds have been described in Fire Control Notes and probably all would work well. One was briefly described by the writer incidental to a discussion of fire tactics in 1959.[2] Even though some units have been used since 1950, for some reason tractor-tankers have not been widely adopted. One man with 100 gallons of water under 150 pounds pressure on a light tractor can give adequate line holding support to a tractor-plow wherever the plow goes.

Prolonged drought makes even ordinary surface fires burn harder and faster than usual, so much so that it is often dangerous for one or even two tractor-plow teams to cross in front of a fire. The head of a fire has a tendency to form a point which sometimes becomes a column of fire. Even parallel backfiring and perpendicular backfiring are difficult and dangerous ways of stopping such a head. This calls for direct attack with water if it could be done.

In the early 1930's when fire control began generally in the southern Coastal Plain, the Civilian Conservation Corps used many small tank trucks on direct attack, augmented by large crews with handtools. The wheeled tank trucks did well until the young pines grew too large for them to ride over. For that reason the tank trucks were practically obsolete by World War II. With the availability of 4-wheel-drive trucks after the war, many new tank trucks were obtained. Even with 4-wheel drive, there are many places tank trucks cannot get to and most of them carry not more than 200 gallons of water. Obviously the tank truck is not suited for direct attack on the head of a difficult fire.

It is well known that, if a break can be made in the center of the head of a fire, the remaining two parts of the head drop in intensity and can be handled. It is also well known that the area inside a Coastal Plain fire is relatively cool and safe. At a guess, the area of active burning (from ignition to completion

[2]Riebold, R. J. Tractor-plow tactics. U.S. Forest Serv. Fire Control Notes 20 (3): 69-76. 1959.

of combustion) on the head of a fire is probably not over 2 chains wide. Therefore, if a tanker could approach the head of a fire from the rear, through the burned area, and extinguish a strip about 2 chains wide for a distance of about 5 chains it would probably break the head of the fire. Five chains probably allows enough for the forward spread of the fire during the few minutes of the attack.

"Head breaker" is the name I would give to a proposed tracked assault tanker to be used for breaking the heads of Coastal Plain fires by direct attack from the rear. The "head breaker" would consist of a 1,000-gallon tank (120 cu. ft.), 8 nozzles, a suitable pump, and an operator's seat mounted on a crawler track and frame. A tracked logging sulky or the tracks and frame of a junked tractor could be used. The front, sides, and bottom would be armored for protection from trees, stumps, and brush. The front bumper should be strong enough to push down trees with the same ability as a D7 or equal tractor. The rear would be provided with a conventional hitch plus pushing bumpers.

To apply the water effectively, the tanker's 8 nozzles should be arranged in pairs. Each pair should consist of a jet and a spray or fog nozzle. One pair should aim forward; and a pair to each side at about 45 degrees. The fourth pair (both spray) should aim downward to protect the tanker itself as it moves forward. The discharge rate would be about 6-10 gallons per minute per nozzle, meaning that the pump should be capable of discharging up to 100 gallons per minute with pressure enough for a large reach for the jets, or fog if fog is found useful. The nozzles would be elevated to obtain maximum reach. The pump can be selected to obtain suitable operating pressures and power.

Any available heavy tractor would be used to pull the assault tanker from the unloading point into the fire and up to the head. At that point the tractor would turn itself and the tanker around and push the tanker into the head of the fire by backing up. With the pump running and all 8 nozzles discharging stream and spray the tanker would simply quench a hole in the head of the fire. If a breakthrough is made, the "head breaker" should widen it by attacking one side of the breakthrough until its water is expended. An advantage of this tanker is that it does not tie up a costly large tractor. Any working tractor, your own or a contractor's, can pull the tanker to the head of the fire and push it into the head during the attack.

Strategically, the "head breaker" would not be considered part of the initial attack force. It would be stationed as reserve at a fire equipment depot or work center. During the worst of the fire season it should be mounted on a lowboy, in readiness. When the boss of the initial attack force determined that the rate of forward spread at the head of the fire was too great for successful angle attack with tractor-plows or if the fire showed signs of high intensity behavior, he should request the assault tanker as part of the reinforcements and a D6 or D7 tractor to handle it. Moving the assault tanker and tractor would require two lowboys and

truck tractors. Additional reinforcement should put at least 4 plow-tanker teams on the fire.

Tactically, the first two plow-tanker teams, if they are not able to make a two-plow attack on the head, should contain and extinguish both flanks up to the anchor points and keep up with the forward movement of the head, one on each side. The two plow-tanker teams arriving as reinforcements should accompany the "head breaker" into the head of the fire from the rear. If a breakthrough is achieved, the two plow teams inside the fire should exploit it by plowing through the break, turning right and left to form a double encirclement with the two plows at the anchor points, which should attack at the same time. Exploitation of a breakthrough must be rapid because the two parts of the head would burn together again in a short time.

With the wind at their backs and the head of the fire moving away from them, the men in the "head breaker" attack group are safer than those in front of a fire on an ordinary attack. There might be some heat but little possibility of exposure to flame. Certainly they would have an adequate escape route. With two men on "head breaker," two men on tractor-plows, and two men on tractor support tankers, there would be only two men, the backfire men, on the ground. They could and should travel to the scene in a 4-wheel-drive vehicle with the attack group boss. With the tractor and tanker equipped with brush guards, no other special safety provisions seem necessary. The use of protective clothing has been considered, but thought unnecessary.

To summarize, here is a proposal to develop a 1000-gallon tanker to break the head of a fire by direct attack from the rear. It is to be on tracks, to be hauled into position by any heavy tractor, to be pushed into the fire behind the discharge of 50 to 100 gallons of water per minute in jets and spray for an attack period of 10 to 20 minutes. The breakthrough should be exploited by plow-tanker teams. With the addition of a mounted swiveled nozzle and the addition of a length of hose in a rack, the tracked tanker could be employed in many other situations for attack and mopup.

In summary. suppression wells with centralized depots of pumps and hose are the tools for dry swamp fires. The light tractor-tanker is the natural teammate for the support of the tractor-plow. The tracked assault tanker is perhaps the next instrument for direct attack and for mopping up.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustrations. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproductions. Please therefore submit well-drawn tracings instead of prints.


Smokey says:
BE SURE
it's DEAD OUT
SMOKEY

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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

VOL 23 NO. 2
April 1962

Forest Service
UNITED STATES DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

UNITED STATES DEPARTMENT OF AGRICULTURE 1862 1962

Growth Through Agricultural Progress

Volume 23 Number 2

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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CONTENTS

RESEARCH IN FIRE PREVENTION[1]

LLOYD M. LAMOIS
Forester, Division of Forest Fire Research, U.S. Forest Service, Washington, D. C.

We in the U.S. Forest Service have been confronted with many fundamental problems in our study of the fire prevention job on wild-land areas. We have barely scratched the surface of what is emerging as a broad and complex subject, and one in which there exists a real need for research activity on many fronts. We feel strongly that close cooperation and free exchange of information among many various fire control agencies will pay large dividends to all who are seeking more effective ways in which to prevent fire.

The number of forest fires has, after a remarkable reduction over the past few years, started to level off to an apparent "irreducible minimum." We are becoming increasingly aware that we must take a second look at this prevention problem. One hundred thousand fires a year are too many to live with in this day of increasing forest values. We are sure, now, that we can, and must, considerably improve our performance in prevention effort.

Our fire prevention research program is being conducted in cooperation with the University of Southern California and with the State of California Division of Forestry. They have accomplished what we think is a thorough overall examination of the many aspects involved in the fire prevention business.

There is much research to be done in which we "firemen" can play only a passive or indirect role. We will find ourselves dealing with aspects of human behavior of which we have barely a speaking knowledge, let alone capabilities for doing meaningful research. Turn the research job over to the "experts." If we "firemen" are imaginative enough to stimulate and guide (or finance) research effort into these avenues, or alleys, we will be doing an important part of the job—but leave the actual human behavior research to experts who know what they are doing.

The very design of test instruments with which to measure awareness, attitudes, and knowledge is a tricky business. Most of the time during the first 3 years of the California project was devoted to the design and testing of questionnaire forms that were sensitive to different levels and kinds of fire prevention knowledge existing among various groups of citizens who used our forests. Fire control men played an important part in selecting valid questions—but the "mix" and the administering of the test were the business of testing experts at the University of Southern California who know how to get *most information* at *least cost* and with the greatest degree of confidence in results.

Essentially, in preventing man-caused fires, we are dealing with problems in human behavior. We have come to break these into

[1] This is a condensed version of a presentation to an assembly of urban fire officers at the Governor's State-Wide Fire Prevention Conference at the State House, Annapolis, Maryland, November 6 and 7, 1961.

three distinct areas of investigation: Education, Law, Environment Modification.

These are the avenues open to us in improving our prevention performance and are, then, avenues we must explore intensively through research. Each has a long list of variables, some subject to manipulation, or controllable; some independent, or noncontrollable. Through manipulation of controllable education and law variables we often can directly modify or change a human behavioral pattern. Occasionally we are faced with educational or law variables we cannot manipulate—then we have the possibility of modifying (engineering) the environment in order to minimize the fire risk from a behavior pattern inaccessible through education or law action.

Education

Research into education variables is largely a study of persuasive communication. We are dealing with the passing-on of information, the giving of instruction, and the driving home of appeals.

We find that most people are very fire conscious but there are many who do not know the full story or intimate relationship between, for instance, the storage of common household chemicals and some of the fire ignition possibilities of electrical wiring, furnaces, match-carrying, and children.

One of the first problems we encounter is "What is the public image of the senders; how credible a bunch are we firemen, anyway?" How people respond to our fire prevention message depends upon the answer to that question.

Let's consider this item—our uniform. What is its impact on the public when we are informing, instructing, or appealing to? I can easily visualize fireman "x" doing his most effective "instructional" work in uniform—where it becomes a symbol of his expertness and credibility. The same fireman "x" might find his uniform a handicap in an "appeal" before a group of business men where it would symbolize self-interest or "begging" instead of objectivity or "straight talk." Almost certainly the answer would vary according to the "public" in concern—whether it is school kids, factory workers, business owners, and whether they are contacted as a group or as individuals. How about the inspection duties: Would the homeowner react more positively to suggestions from an inspector in a business suit or one in uniform? Some of the answers we get to these questions may hurt; some we can do something about; others we may have to live with. At any rate they will give us valuable clues as to the potential effectiveness of any educational campaign we may contemplate.

The message itself is another matter of concern, especially in the job of instructing. We have been very successful in conditioning attitudes, through mass media; but so-far, we have managed to contribute little in the way of how-to-do-it information. For instance, our California questionnaire revealed that the need for hazard reduction around buildings was an item that the average

forest resident thought very little about. Also, there is a lack of knowledge about burning permits. Many did not know that permits were required to burn trash. Many others thought that campfire permits issued by a National Forest officer were valid in any forested area, not just on National Forest land.

In general, the first survey returns were discouraging when we consider the public's knowledge of fire regulations. A clue, here, to prevention action on our part is the fact that nearly one-half the people surveyed thought that law information was difficult to get. Significant also is the fact that regulations most often broken involved forestry or land use "jargon" which was often obscure or entirely meaningless to the forest visitor.

Another variable is the media that carries our message. Here again is that important matter of credibility. Various media have vastly different "credibility ratings" with different audiences. For example, certain rural audiences have strong identification with their local radio station, but may tend to distrust "government propaganda" from large, metropolitan stations.

A most important variable in fire prevention education is the receiver of your message. The primary problem here is to break down the "public" into "publics." We now consider two groups of forest users, the visitor and the resident. Each is identified with a certain set of fire situations. We must learn how to break these two groups down into more specific "publics;" i.e., summer resident, farmer-rancher, fisherman, camper, hiker, and so on. Each of these small "publics" must be measured and equated with specific fire risks. They must be studied to reveal from whence they receive their fire prevention knowledge and attitudes. All this is aimed at the eventual pinpointing of special messages to specific targets through highly selected media.

Law

Law and its enforcement must never be relied upon as a substitute for education.

The first item of research into the role of laws in fire prevention is a study of the statutes themselves. Are they adequate? Does the language unmistakably cover specific trouble situations, or is it ambiguous and full of loopholes? How selective is the system of regulations and ordinances? A particular prevention problem may manifest itself only in some areas and not in others, or in one particular season of the year more than another. Where a selective ordinance can solve a particularly troublesome situation, good records should reveal the fact and existing regulations should be adjusted to take care of it.

More important than the statutes themselves is an incisive insight into enforcement action of agency personnel. Foremost, here, is the question of existing enforcement policy of the agency. Is it uniform from unit to unit of the agency; or is there a good deal of flexibility, leaving room for individual differences from Forest to Forest or borough to borough? Are the people confused?

The need is outstanding for research in the realm of public attitude toward law enforcement aimed at better fire prevention. We find four essentials here. If an agency is "missing the boat" on one or more of these, research should reveal the fact.

a. The public must feel that enforcement personnel are active and alert for offenders.

b. The public must feel that the regulations are just and reasonable; that is, with respect to enforcement action.

c.. The public must know that if a violation is observed, action will be taken. This means official action, not just a passing comment by the enforcement officer.

d. The public must feel that penalties involved are adequate but equitable (stiff but not unduly severe).

There also is a problem of *actual* versus *implied* enforcement. Implied enforcement is almost "education" in that it aims to alter behavior prior to violation; e.g., conspicuous patrol in critical areas. More attention to "implied" aspects of the enforcement program may in many cases result in far less involvement in actual (often unpleasant) enforcement situations.

The law violators deserve the attention of our research effort. The key problem here is the identification of representative and nonrepresentative behavior. Is a certain behavior pattern of a given violator typical of our average forest visitor, or home owner? Or can we assume that this certain behavior pattern is a good indicator of potential violation of a fire law? For instance, we discovered that fire law violators had histories of traffic citations in an order of 3 to 1 over nonviolators. What is the effectiveness of the penalty or treatment of the violator? Will his experience result in his being a better or poorer risk as a fire source?

Environment Modification

In some cases, modifying a fire environment may prove cheaper, simpler, and more positive than either education or law in doing a specific fire prevention job. In the Forest Service we think in terms of "use" patterns, such as the cycling of logging operations inasmuch as the accumulation of slash is affected. The building of camping facilities with incinerators, fireplaces for cooking, and water source is also an example of this type of work on forest lands.

We also directly manipulate fuel situations through mechanical or chemical disposal or carefully controlled burning of logging debris or by constructing firebreaks along an exposed area of hazardous fuels. The thing to remember here is that the modification of a physical situation is linked closely to a human behavior pattern. By simply moving a paper trash box in a school building out from some dark corner, where kids are apt to sneak a smoke, into a more conspicuous spot in the hallway, you may "engineer" the prevention of a school disaster.

Those factors which we cannot modify (weather, topography, fuel types) we must learn how to measure in terms of their impact

on fire occurrence, then adjust our education effort and law enforcement in ways which minimize the importance of these noncontrollable elements.

Summary

In summary then, we have explored our three main avenues which we hope will lead to some answers we do not now have; answers which should allow us to strengthen considerably our total prevention program.

1. We expect our research into education problems to sharpen our approaches to "educating the public." We must learn to identify specific "publics" and discover about each exactly what prevention problems exist, what we must say and in what manner and through the most efficient media.
2. By studying the role of laws and their enforcement in the fire prevention job, we hope to learn how to more effectively augment our education effort, especially where we have failed to "educate" away carelessness and lack of knowledge and where "malicious" and "habitual" sources are inaccessible to education.
3. Finally, research into environmental variables should teach us much as to which are controllable and which are not and what we should do about each.

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Ten Hours Sleep and Thirty Cigars

Along about the 20th of November the Export Timber Company sent 30 men to Lurton to cut and haul staves, as the Company was putting in a mill at Lurton.

I had got a handful of buttons at the Forest Office that read "Prevent Forest Fires." I met these 30 men at the store at Lurton, and got right in the midst of them and explained that we were trying to grow timber to keep mills like they had running and to do this we had to keep fires out of the timber. I then gave each man a button except one boy. He said, "I don't want it." I then started to work to get one on his coat. I would go to the campe at night, play pitch with them and quite often I would get this boy for a partner. I wore one of the buttons on my coat all the time. In about five nights, this boy asked for one of the buttons, and he has it on his coat today. This cost me an hour or two sleep for five or six nights and thirty or forty cigars.

BUT I CAME OUT WITH THE BUTTON WHERE I WANTED IT.—Douglas Shaddox, *Road Foreman, Ozark National Forest.* [An exact copy of an undated report in the files of the Ozark N.F. The year is believed to have been 1930. The principle illustrated is the value of appropriate and timely personal contact—a principle as valid and important today as in 1930.—Ed.]

ARE WE TAKING SMOKEY BEAR FOR GRANTED?

NORMAN P. WEEDEN
Director, Cooperative Forest Fire Prevention,
U.S. Forest Service, Washington, D. C.

As times change, our problems change, and the approach to solving these problems change, too. This truism also applies to the effective programing of the Cooperative Forest Fire Prevention Campaign, commonly referred to as the Smokey Bear Program.

Let us look back to the beginning of the campaign—back to 1942. The Wartime Forest Fire Prevention Campaign was started to minimize natural resource destruction by wildfire due to enemy shelling and bombing and to minimize the loss of firefighters to the Armed Services. Forest fire prevention became one of the first public service programs of the War Advertising Council, now The Advertising Council, Inc. The advertising agency Foote, Cone and Belding volunteered to plan the yearly campaigns; Russell Z. Eller, Advertising Manager of Sunkist Growers, Inc., became the coordinator; and the U.S. Forest Service and the Association of State Foresters were the clients. This cooperative arrangement has remained unchanged through the 20 years the program has been in effect. The first campaign kit included posters, radio scripts, newspaper ads, and bookmarks.

From the first campaign kit, we have come a long way in our mass-media approach. In 1961 the campaign produced and distributed more than 20,000,000 pieces of new material, including pamphlets, easels, bookmarks, tent cards, calendars, coloring sheets, stamps, song sheets, decals, bumper stickers, newspaper ad proof sheets, envelope stuffers, and a variety of posters. Almost 100,000 car cards of three different sizes were printed and sent to The Advertising Council for distribution to transportation companies throughout the country for display in street cars, subways, and buses. Through The Advertising Council, 6,500 of the large display posters (3-sheet) were placed in airports and railway stations, and in outside displays. A television kit, containing 6 different spots, 1 minute, 20 seconds, and 10 seconds in length, was sent to all television stations throughout the country and obtained over 2 billion home impressions. The campaign received, free of charge, public service time from radio and television broadcasters estimated to be worth $14,000,000. Equally valuable space was donated by newspapers, magazines, outdoor advertisers, and transportation companies.

More than 250,000 Junior Forest Ranger Kits were mailed to children writing in asking to become Junior Forest Rangers. As a result of a Captain Kangaroo show televised nationally, featur-

ing Smokey Bear and the Junior Forest Ranger program, 105,541 requests were received in the month of October alone.

A teachers kit, aimed at the primary grades, was developed and is now being sent upon request to teachers throughout the country. Demand for these kits, now almost 200 a month, is increasing daily. These teachers reach a young audience of approximately 80,000 a year with a concentrated course in forest fire prevention and an introduction, through Smokey, to a future appreciation of conservation.

The commercial licensing program, now 9 years old, is an important function of this office and has earned over $220,000 in royalties in that time. These funds are used to implement the nationwide forest fire prevention program. At present, there are more than 30 commercial licenses in effect, covering production of such varied Smokey Bear items as dolls, scarves, comic books, milk mugs, belts, T-shirts, cigaret snuffers, books, games, banks, toys, cookies, ash trays, calendars, pen and pencil sets, and litter bags.

A supplemental program called the Southern CFFP was organized in 1959 to combat the specific fire problems in the 11 Southeastern States. More than half the man-caused fires of our country occur there. Operating on a budget of only $17,000, this program is aimed at an adult audience and has as its goal the reducing of incendiary and malicious woods burning. For the past 3 years television spots, newspaper ads, radio platters, posters, and envelope stuffers have been produced and distributed for this purpose.

Has the Smokey Bear Program paid off? No study has yet been made to determine why man-caused fires were held under 100,000 for each of the last 5 years as compared with 205,000 in 1942. We can only point at this record and say, "We have helped." Campaign costs have increased from $25,000 in 1942 to $270,000 in 1961. This investment has resulted in an estimated savings in resource damage of ten billion dollars over the past 20 years—or half a billion a year. This is really a small investment when the final returns are calculated. Has the campaign been so successful it may be discontinued? The answer is an emphatic "NO."

There are still too many man-caused fires. The cost of suppressing these fires runs into tens of millions of dollars each year. As our population grows and more people use the great out-of-doors, fire risks increase proportionately. We can't possibly reach every man, woman, and child personally—we must rely on the mass-media approach supplemented by local effort to make people aware of the fire danger. Because Smokey has become famous—seen on television, or a poster, or a newspaper, or any other handout item, or perhaps heard on the radio—are we taking him for granted? Have we, in the field of forest fire prevention, reached the point where we say we have exploited every possible means of communicating our message, "Remember only *YOU* can prevent forest fires"? Not by a long shot.

How can we better reach 180,000,000 actual or potential forest

users today and the generations to come? There are many ways, and the future will suggest many more. Here are some of them:

1. A better understanding of how to use each and every CFFP item now being distributed; this will require intensive training.

2. Fuller use of materials now being distributed to overcome any tendency to let materials accumulate in warehouses and storerooms. Again, training, followed by inspection at all levels, is needed.

3. Better use of radio as a mass-media tool. The radio audience of today is much greater than the television audience. Our goal is to produce material annually that program directors will use, with emphasis on a greater variety of short public service announcements. Short spot announcements in script form prepared at the local level can also be effective.

4. Better coverage in magazines at national, regional, and local levels. Here again, we have just scratched the surface. More people are reading more magazines than ever before. We see many opportunities in this field.

5. In television, the use of Smokey Bear and other forest fire prevention materials in local programs by the station's own TV personality. Some of these people are doing an outstanding job of teaching prevention to local juvenile audiences. Billy Johnson, of WLW-A, Atlanta, Georgia, for example, reaches thousands of children in his daily programs. Here, too, local effort is necessary to get the programs going.

6. Working closely with the primary grade school teachers. There are approximately 5,000,000 children in the first four grades and a million more start school every year. The job of reaching these children may at first glance seem to be an impossible task, but the teachers reach them every day. Informed of our program, and aware of the materials available, these teachers can get our message to every child in America.

7. Further expansion of Smokey Bear Reading Clubs such as the one developed as a joint project by the South Carolina State Library Board and the Commission of Forestry in 1955. This idea has caught on and State Foresters have developed similar projects in other States. These are programs with a forest fire prevention and general conservation theme. It provides selected reading materials at the libraries for children, and rewards them for reading a certain number of books.

8. An earnest willingness in all of us to take these steps and find other ways also that will help the program. Let's not just rely on Smokey. He's doing a good job, but the main job in the final analysis is up to us.

ETHICS OF WOODS BURNING—A KEY TO PREVENTION

W. I. WHITE
U.S. Forest Service, North Central Region

[This article is reprinted from the December 1936 issue of Fire Control Notes. We feel that it contains a truth as important today as it was then.—Ed.]

It seems to me that we have been pretty generally overlooking what is probably the most potent force available for real fire prevention. This force, if once aroused, will accomplish more thorough and permanent results with many people than all the arguments commonly used in preaching fire prevention. I mean the ethical sense of right and wrong.

In many parts of our forest domain, particularly in the lower Mississippi and Ohio valleys, the economic status of the rural residents within the forests is very low. It has traditionally been so, and in spite of our various plans for social uplift, the thinking and habits of a community cannot be changed over night. Discussions of economic betterment, land use planning, conservation of resources, etc., are often entirely meaningless to an Ozark mountaineer who has been taught from the cradle to believe that what was good enough for his "pappy" is good enough for him.

On the other hand it has been amply demonstrated and reported that the residents of many of these communities of low economic status have a very deep and forthright religious feeling. Even though they may not be able to discriminate between good and poor farming practice, between wasteful and conservative use of land, they do have a well-defined sense of right and wrong.

Why not, then, elevate our consideration of woods burning to an ethical plane and consider it from the standpoint of right and wrong? A man who may not be able to see any economic advantage in allowing his woods and fields to go unburned may perhaps be brought to feel a sense of stewardship for the natural resources which the Lord has placed at his disposal. Or, allowing a fire to damage his neighbor may be placed in the same category with stealing his neighbor's cow. Throwing down a burning match or cigarette by the roadside may be likened to doing the same thing in a powder magazine.

As a means toward establishing this principle in the communities where woods burning has been done deliberately for many years, I suggest that our field men make it a point to cultivate the acquaintance of the preachers who work in the forest communities, attend their religious meetings, and definitely align themselves with the apostles of right and truth. I believe that by tactful contacts the matter of malicious or uncontrolled woods burning can be brought out into the open and mentioned specifically in meetings of this kind as an unethical thing to do, the same as lying, or stealing, or beating one's wife.

There is no question about the preacher being a leader in the sort of community of which I speak, and the local Forest Officer can make no mistake by being definitely and clearly on his side.

Certainly, if the deliberate or careless setting of fires can be given a definite stamp of disapproval by the right-thinking people in any community, many other acts of trespass and evil-doing which give our law enforcement officers gray hairs will be greatly reduced also. Let's give it a trial!

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Are You Missing the Woman's Touch?

The familiar words "never underestimate the power of a woman" has, perhaps, become a tiresome and overused phrase. It is used (more often than not) in a facetious vein. But, seriously, have you thought of asking "the girls" to help prevent forest fires? If not, you are missing a bet.

Most women belong to a club of some kind, whether they are housewives, school teachers, business women, or retirees. And, most of these clubs concern themselves (or should) with conservation of natural resources. Here is a built-in organization to "spread the gospel" about forest fires and it is yours for the asking.

Women like to assist any "cause" which makes their communities a better place to bring up their children. They devote many hours as adult leaders of Girl Scouts, Camp Fire Girls, Cub Scouts, and church and other youth groups. They are, therefore, a receptive audience when reminded of the devastation of forest fires and the need for preventing them. Their clubs sponsor Smokey Bear coloring contests, essay contests, set up conservation shelves in schools and libraries, plant trees—to mention just a few activities.

Foresters are sometimes reluctant to "tackle" the President of the woman's club, garden club, P.T.A., or whatnot for fear of having to balance a cup of tea at the next club meeting. Be brave; it might not be necessary to go to the meeting. Begin at home; your wife will help you and probably have good suggestions for enlisting others. All Forest Service Regional Offices (except Alaska) now have a person in women's activities who will explain organization and objectives of various women's groups and how best to approach them. They also will suggest projects and assist in accomplishing them.

Now that your courage is up, go after distaff assistance in preventing forest fires.—Elizabeth Mason, *Division of Information and Education, U.S. Forest Service, Washington, D. C.*

ONTARIO FIRE SEASON—1961

W. T. FOSTER
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Ontario Department of Lands and Forests

The Province of Ontario during 1961 experienced one of the most severe fire seasons in recent years. Although the number of fires, 1,305, is about the annual average, the area burned totalled 1,184,998 acres, twelve times the average annual loss during the past decade. The region of heaviest occurrence and damage was the northwestern part of the Province, west of Lake Superior to the Manitoba boundary. This area suffered from extreme drought and burning conditions while the remainder of the Province enjoyed a better than normal season.

The critical period of occurrence and spread lasted 28 days, between June 15th and July 12th. The stage for the 1961 fire season was set back in 1958, the beginning of a period of much below normal precipitation and light winter snowfalls. This period of low precipitation contributed to a fairly heavy fire load in the region during 1960—this, as it turned out, was only a "preliminary" for 1961. The build-up of unfavourable conditions was well recognized prior to the 1961 fire season. It was particularly emphasized by the water inflow data for the two major lakes and drainage areas affected. Lake of the Woods was 58 percent of normal and Lac Seul 42 percent of normal for the period October 1, 1960, to April 15, 1961.

After widely scattered thunderstorms over this region of some 100,000 square miles during the second and third week in June, the "fire build-up" produced three lightning fires on June 15th, the number increasing on June 18th to 20 new fires. By July 1st, 158 lightning fires had occurred of which 107 had been extinguished. A total of 244 fires occurred during this period; 12 of these accounted for 1,124,500 of the acres burned.

Major spreads took place on June 24th and 28th on fires in the Pickle Lake and Lac Seul areas in the Sioux Lookout district and at Boundary Lake in the Kenora district where a large fire crossed into Ontario from Manitoba on the 24th. Fires were reported spreading as much as 10 miles on the afternoon of June 28th. Lightning storms continued to plague firefighters and a storm on the evening of June 26th resulted in several new fires including two major fires that would pose a threat to the community of Red Lake. Strong shifting winds, severe burning conditions, and smoke hampered aircraft operations, fire detection, and fire servicing throughout the period.

On June 28th the Minister of Lands and Forests imposed a Forest Travel Ban in the Sioux Lookout district; Kenora district

was subsequently closed to travel on July 4th. The travel closure was imposed to reduce the risk of additional fires and for the safety of people who had entered the threatened areas.

On June 30th weather reports indicated particularly severe burning conditions for July 1st—high gusting winds and low relative humidity. All headquarters and fire crews were alerted to take special precautions. By noon of July 1st, men were removed from dangerous sectors of fireline, and camps in critical positions evacuated. Approximately 60 women and children were evacuated about midday from Valora, a small community on the Canadian National Railway line about 130 miles northwest of the Lakehead cities of Port Arthur and Fort William. Valora was threatened by two major fires 6 miles to the southwest.

One hundred and fifty miles farther to the west two major fires that threatened the Red Lake area created a tense situation for this mining community of 5,000 people. Emergency plans had been put into effect with the co-operation of the town council, the Ontario Provincial Police and mine officials. The community was well organized should the fires force an evacuation. Firebreaks were constructed, emergency waterlines laid, and all available pumping equipment, bulldozers, water-dropping aircraft, helicopters, and manpower were mobilized. About 4:30 p.m. one fire about 5 miles south of the community burned across the Red Lake highway and a hydro line temporarily disrupting power, telephone service, and road traffic. This fire spread about 9 miles eastward on a narrow front to the shores of Gull Rock Lake where it destroyed a large tourist camp. The other major fire 6 miles to the east of the community spread to 30,000 acres on the afternoon of July 1st.

The strong winds which continued to blow from a westerly direction were favourable in that they kept the fires from advancing on Red Lake itself. Firefighters eventually controlled both fires without further damage, but the threat to the community was not entirely eliminated until July 18th.

To the northeast of Red Lake, 165 miles away, another mining community, Pickle Lake, was completely blacked out by smoke from fires. Dense smoke and high winds made it impossible for aircraft to operate, determine what new fires may have occurred, and ascertain how far old fires had spread. Winds during the afternoon of July 1st were westerly at 30 m.p.h. gusting to 60 m.p.h. Temperatures were in the high eighties and the low relative humidity was 22 percent.

Fortunately on July 2nd, the winds lessened and the humidity increased sufficiently to create a lull in the fire spread permittting firefighters to be regrouped and control efforts intensified. In spite of lack of rain, a continuance of severe burning conditions, and additional lightning strikes, all fires in the higher value, accessible forest areas were gradually brought under control.

Several fires which accounted for the major portion of the acreage burned over were in the most northerly inaccessible forest

areas beyond present economical timber harvesting operations. These fires, because of the existing circumstances, were attacked by small, highly mobile crews using helicopters and light aircraft to strike at favourable points to gain control. Helicopters were used effectively to mop up large fires; on one fire a helicopter crew put out over 300 smudges.

To meet the fire situation Department personnel and equipment were mobilized throughout the Province and there was an orderly flow of firefighting resources, based on day-to-day requirements, into the fire area. The movement of assistance from outside the Western Region started on June 17th with the South-Central "Project Fire Team" of 17 supervisory personnel going to Sioux Lookout. Four water dropping DeHavilland Otter aircraft were flown into northwestern Ontario to assist the four Otters based in the area. Four additional Beaver aircraft from eastern Ontario and all five Department helicopters were moved into the region. In addition to the 28 department aircraft operating in the area, the Royal Canadian Air Force provided two large helicopters, Ontario Hydro Electric Power Commission two more, and the Department requisitioned the services of four additional helicopters. A large water-dropping Canso flying-boat and up to 31 commercial float-equipped machines were employed. A total of about 70 aircraft were engaged at varying periods.

Water dropping was considered a major factor in successful fire attack in several instances. During the 1961 season, 843,500 Imperial gallons (1,012,200 U.S. gallons) of water was dropped on 104 fires in Ontario.

During the emergency period, over 200 experienced Department personnel from other sections of the Province moved in to reinforce district staffs at Sioux Lookout, Kenora, and Fort Frances. Over 300 pumping units and a million feet of fire hose, handtools, and camping equipment were shipped from caches and other districts to supplement the normal complement of equipment located in the fire areas. As many as 2,600 extra firefighters were recruited at the peak of the control operations.

On July 12th light rains came bringing the first relief in a month. The Forest Travel Ban was lifted on July 13th and the summer-long job of mopup and cleanup was underway.

EFFECT OF 1956 SOUTHERN FIRE CONFERENCE DEBATABLE

JAMES E. MIXON[1]
State Forester of Louisiana

A letter survey and discussion around the Southern States indicate that indirect far-reaching results of the fire conference are evident, but the good is a matter of degree.

It is apparent that the judiciary and press became more aware of the problem of incendiarism and some were motivated to take more severe action, though these were considered in a minority.

It is probable that the increases in State appropriations generally enjoyed over most of the South since 1956 were influenced by the fire conference. Some credit is given here to the conference.

The survey does not show any relationship between State or county followup meetings and fire occurrence in incendiarism or debris burning. It would seem that the fire record would give the truest picture of conference influence.

In the Southern States the relation between total fires and incendiary and debris fires for 5 years before and 5 years after the conference is as follows:

	Total Fires	Debris burning fires Number	Debris burning fires Percent	Incendiary fires Number	Incendiary fires Percent
1951	75,559	13,469	17.8	36,259	48.0
1952	83,523	15,551	18.6	37,204	44.5
1953	60,455	12,878	21.3	25,734	42.6
1954	94,120	21,558	22.9	37,083	39.4
1955	56,784	13,234	23.3	22,739	40.0
5-year av.	74,088	15,338	20.7	31,804	42.9
1956	59,324	14,440	24.3	20,787	35.0
1957	31,156	7,958	25.5	11,668	37.5
1958	42,030	10,323	24.6	16,534	39.3
1959	47,441	14,998	31.6	17,472	36.8
1960	50,073	13,614	27.2	17,701	35.4
5-yr. av.	46,005	12,267	26.7	16,832	36.6

It is interesting to note that in relation to the total number of fires debris fires increased 6 percent after the conference while incendiary fires decreased almost the same amount or 6 3 percent. Several factors, such as the three that follow, may well be considered.

1. Several State Forestry Agencies expanded their law enforcement personnel and facilities in the period following the conference.

[1] Jim Mixon, State Forester of Louisiana, was an organizer of the Southern Forest Fire Prevention Conference at New Orleans in 1956. He has vigorously pressed a fire law enforcement program in Louisiana. Jim, early in his career as State Forester, declared war on those who deliberately set fire to woodland and so jeopardize life, property, and our economic future.—Ed.

2. During this period a reinterpretation of fire causes was disseminated to the personnel making fire reports; the new interpretation disrupted the uniformity that prevailed on causes in the period prior to the conference. This is certainly true in Louisiana.

3. Climate cannot be overlooked. Most of the South experienced a 2- or 3-year wet period in the second 5 years. This may be construed to indicate that the debris burners became careless after repeated efforts to burn debris and thereby possibly increased their percentage. On the other hand the arsonists kept waiting to "burn when the wind is high." Their chances were fewer; this could explain why their percentage dropped.

Some States feel that the fire conference had no effect in reducing incendiary or debris fires, because those who start such fires are seldom influenced by education. Yet, in spite of the marvelous preparations for the conference and the outstanding talks, some of the speakers persisted in pushing for more education.

In my opinion, education has not reached the woods burner and never will directly. The deliberate burner has not changed. Although it is six years since the conference, I still do not believe that education will reach the burner.

The Southern State Foresters generally agree that the Southern Branch of the National Cooperative Forest Fire Prevention Program was formed as a result of the conference. This is good. The program is in its third year and getting stronger. It is aimed at responsible citizens and in bold approaches makes an effort to motivate them to help stop the arsonist. I feel that this kind of education will ultimately pay off though it is indirect.

In summary, I see no direct improvement effect on the percentage of debris or incendiary fires as a result of the 1956 fire conference in New Orleans and subsequent followup State or county meetings.

Continuing programs and effort, however, have brought improvement to the South. There has been expansion in enforcement personnel in some States, better cooperation with the judiciary has been reported by some, some States have enjoyed appropriation increases at a more rapid pace, the Southern CFFP is active on the problems of arson and debris burning, and some States have brought new acreage under protection.

A SMALL AERIAL PUBLIC ADDRESS UNIT FOR FIRE CONTROL USE

RICHARD A. CHASE, *Assistant Fire Staff Officer*, and
DON E. FRANKS, *Fire Control Officer, Deschutes National Forest*

The need for a public address unit for air to ground communication often arises in fire control work. Frequently, smokechasers do not have portable radios, nor do all crews on the fireline, and instances arise when an aerial observer has information to pass on to these ground forces.

Generally, the planes used for fire patrol and reconnaissance are light craft rented from private operators. Often the same plane will not be available each time one is needed. Therefore, any loud-speaker system to be used in these planes must be light, compact, and easily mounted and demounted, so that it can be readily switched from plane to plane. At the same time, it also must have sufficient power and fidelity to carry the voice clearly a reasonable distance under the adverse operating conditions encountered.

FIGURE 1.—Amplifier speaker mounted on a Cessna 180; closeup showing bracket.

One unit which meets the above requirements is rated at 50 watts; the 14-volt amplifier and speaker unit is completely transistorized, lightweight and compact. An additional feature is an electronic siren which is very effective in attracting attention before a message is started. Cost is approximately $260.

A few minor additions to the basic unit made installation simple. The amplifier is small enough to sit on the floor between the observer's feet, and an adapter on the power cord allows it to be plugged into the cigarette lighter. A bracket fitted on the speaker horn provides easy attachment to the landing gear strut (fig. 1).

Since the speaker is very directional (a factor in the unit's ability to carry the voice clearly under the operating conditions) it must remain aimed at the person being spoken to, for best results. During tests the noise of the aircraft's engine tended to drown out the message. To overcome this and satisfy the first requirement, it was found that excellent results were obtained by climbing the plane to approximately 2,000 feet above the ground, cutting power and descending in a flat spiral over the location of the message's recipient. Banking the plane as it circles keeps the speaker properly aimed, and a fairly long message can be given, or a short one repeated a number of times.

The key to successful performance is adequate practice by both the pilots and the observers who will use the unit. By trying the unit in the air and listening on the ground, the suitable aircraft flight pattern and the proper voice level, inflection, and speed are soon determined.

One unit used by forest personnel during the 1961 fire season won wide acceptance. It proved invaluable in directing smokechasers without radios to several small lightning fires in timbered areas, thereby eliminating many man-hours of search and speeding up initial attack. In one instance, it was used to call back two firemen searching for a back-country smoke that had subsequently disappeared. This was possible even though the plane could not see the men and, in fact, was not sure of their exact location.

Other uses for this aerial public address unit are warning crews of changes in fire behavior, alerting ground forces to spot fires and directing men to them, and even broadcasting short fire prevention messages to campers during critical fire weather. While the system has the limitation of not being able to blanket large areas with a message, it does adequately perform in those instances where the aerial observer has valuable information for an individual or small crew on the ground.

FLORIDA FOREST FIRE PREVENTION COMMITTEES

FLORIDA FOREST SERVICE

In any drive or movement requiring public support, the more people who can be involved, the more likely the objectives are to be reached. This is particularly true if community leaders are involved. Florida's Forest Fire Prevention Committees were organized with this fact in mind. The committees didn't "just happen." They were the outgrowth of efforts to get the forestry job done during rapid extension of fire control and other Florida Forest Service activities.

During the early 1950's, the many counties just brought under fire control presented two serious problems—fire prevention and financing. It seemed worthwhile to enlist some local help to work on both. The Florida Forestry Association agreed to appoint men selected by the Florida Forest Service to serve on county committees under the Association. It was felt that this arrangement would be beneficial to both the Florida Forest Service and the Forestry Association. Many of these committees served well. Such county groups have been used in other Southern States, although details of appointment and duties vary. Georgia has County Forestry Boards, and South Carolina has County Forestry Committees.

In 1956, at Florida meetings held as a followup of the New Orleans Fire Prevention Conference, a resolution was passed urging the legislature to provide for State and County Forest Fire Prevention Committees. Florida's lawmakers complied with this request during their 1957 session by amending the Forest Protection law to provide for these committees to be appointed by the Florida Board of Forestry.

To date, committees have been organized in 56 out of 67 counties. District Foresters, district personnel, and county personnel recommend people whom they think would make good committee members. These names are screened, and a final selection is recommended to the Florida Board of Forestry by the State Forester. Members are appointed for 2-year terms and serve without pay. Every effort is made to have each committee include a cross section of interests and activities in the county—bankers, business men, farmers, small landowners, newspaper men, civic club leaders and garden club and women's club members, although not all are included on each individual committee. Each committee must have at least five members, but most committees have six to eight. The State Committee is made up of twenty-five representatives from all parts of Florida. Most of them serve on county committees.

Committee duties are to assist the Florida Board of Forestry and the Florida Forest Service in implementing the policies and programs of the Florida Board of Forestry, to assist in forest fire prevention, law enforcement, tree planting, forest management,

and other forestry activities when called upon to do so by the Board.

As might be expected, some committees are more active than others. A considerable amount of work is required to orient the committee members and to keep them interested, active, and helpful. In one meeting where we were trying to determine how we could breathe life into some of the committees and how we could help others to help us, we reached the conclusion that the prime responsibility for successful committee action rested on the Florida Forest Service. If a committee is inactive, it is either because we made the wrong selection of members or we failed to take the necessary steps to keep the committee interested and active.

Activities have varied greatly from one county committee to another. This is as it should be, as no two counties have identical problems.

One committee has set up a project for the four chapters of Future Farmers of America, located in four sections of the county, to compete in a contest to reduce careless, man-caused forest fires. Cash prizes will be awarded to the chapters with the greatest percentage reduction of fires in their areas. Another county has arranged with county school officials to have every sixth grade class in the county visit a Florida Forest Service Headquarters to learn how fires are located, how trucks are dispatched, how equipment works, how fires are fought, etc. Another committee has worked with the Chamber of Commerce to provide "show-me" trips to forest industries. One county committee purchased 10,000 litter bags with a forest fire prevention message and distributed them through filling stations and restaurants. Another committee prevailed upon the County Commissioners to make and erect metal roadside signs with a forest fire prevention message. Several committees have held essay or poster contests for school children and have furnished prizes.

Activities have not been limited to fire prevention. Several committees have worked with law enforcement officials and other county officials to provide better enforcement of the fire laws. Several counties have assisted in establishing farm forestry projects, and in one county the committee paid half of the county's payment for the farm forester when the county ran out of money. Tree planting machines have been secured by at least three county committees for local use.

We cannot point to any particular reduction of fires and say that the County Forest Fire Prevention Committee was responsible for this reduction. It is difficult, and often impossible, to attribute a specific reduction of fires to a specific fire prevention effort. We know, however, that there are some things—legislative contacts, for example—that committees can do more effectively than the Forest Service employees. And, the more coordinated are the efforts directed toward preventing forest fires, the smaller will be the fire damage to our forests.

We feel that the County Forest Fire Prevention Committees have helped us in the past few years and will be of even greater help to us in the future.

A PROFILE OF THE CALIFORNIA HUNTER

JAMES B. DAVIS, *California Division of Forestry,* and
CRAIG C. CHANDLER, *Pacific Southwest Forest and Range Experiment Station*

On June 6, 1944, the Allies opened a second front in Europe with the Normandy Invasion. The 320,000 men that went ashore that first week constituted one of the largest expeditionary forces the world has ever seen. Yet every year almost twice this many armed men and women invade the forests and wildlands of California: 560,000 licensed hunters.

The great majority of these people want and try to be careful with fire, but their numbers alone constitute a serious fire risk. In addition, hunters are a *special* problem. Hunting (deer hunting in particular) is a solitary, back-country sport. The hunter does not have neighboring campers available to extinguish his fire if he leaves it. He doesn't stay in improved campgrounds where the hazards have been removed for him. He may make a dry camp, where water must be packed in for miles and too little is available to drown breakfast or warming fires. He is in the woods mostly during the dry summer and fall months when forest fuels are most flammable.

All in all, the hunter is in an ideal position to start forest fires. And he does. To avoid disaster, the hunter must be *more* careful with fire than other forest users and the forest fire agencies must see that every one of these men and women *is* careful with fire.

To give fire control agencies the best possible tools for their prevention job the University of Southern California, in cooperation with the Pacific Southwest Forest and Range Experiment Station and Region 5 of the U.S. Forest Service and the California Division of Forestry, has undertaken a large-scale study of the fire prevention knowledge and attitudes of the State's hunters.

With the help of the California Department of Fish and Game, we polled 2 percent of the State's hunters: a random sample of 10,000 drawn from 560,000 carbon copies of hunting licenses sold in 1959-60. The carbon copies served as a source of additional information and a check on the representativeness of replies to the University of Southern California questionnaire.

Questionnaires were mailed to the entire sample population. Three types of information were requested: "vital statistics," answers to 16 multiple-choice questions relating to fire prevention knowledge, and a rating of sources of fire prevention information. Here is what we learned about the hunters' vital statistics and a preliminary analysis of their sources of information.

Who is the California Hunter?—When you think of a "hunter" you may get a definite mental picture. If so, discard it. Hunters in

California are an extremely diverse group. The best we can do is describe the range of characteristics of this population and thus put some sideboards on our mental picture of the hunter.

How old are they? Hunting, at least in California, is largely a sport for men in the "junior executive" age bracket. When comparing the ages of hunters to those of all California residents 15 years old and over, we found fewer hunters than expected at all ages from 15 to 25, more hunters than expected at all ages from 25 to 50, and fewer at all ages over 50.

Since hunting is an active sport, it is not surprising to find participation falling off with increasing age. But why the lack of enthusiasm for hunting by men under 25? Several possible explanations have been advanced, ranging from a lack of financial resources to the theory that the younger generation does all its hunting indoors.

Only 7 percent of the State's hunting licenses are purchased by women, but this may be a misleading statistic in fire prevention work. An earlier on-the-ground survey of 474 deer hunters in northern California found 144 women and 330 men. Evidently many women enjoy the sport as a camping out experience but do not purchase a license.

The occupations of California hunters varied so widely as to make meaningful comparisons virtually impossible. We found choker setters, set designers, hairdressers, and seaweed inspectors. However, more than two-thirds had "indoor" occupations where no meaningful contact with fire prevention problems or practices could be expected.

Where Do Hunters Live?—Most hunters come from smaller communities. Fifty-six percent of them were from towns with a population of under 20,000, compared to 41 percent for the general population. Only 14 percent had addresses in cities over 250,000, compared to 28 percent of Californians as a whole. This does not mean that most hunters come from rural areas; it may be just a peculiarity of California's geography. One in every two Californians lives in the five-county Los Angeles area in the southern end of the State, but only 25 percent of the hunters. Because of the climatic pattern, almost all hunting country is in the central or northern parts of the State. The seven-county Bay Area complex is fully as industrialized as Los Angeles, but much nearer to hunting opportunities. Here we find 20 percent of the hunters and only 16 percent of the State's population.

Where Do Californians Go to Hunt?—We can't answer this question directly with the data available from the survey. But we can get some useful clues since we know both the hunter's home address and the place where he bought his license. We can identify hunters who travel from home to a hunting area and buy their license on arrival, but we cannot identify those who buy a license at home, then travel to another area to hunt.

In the extreme northern part of California, 35 percent of the licenses are sold to nonlocal residents, in southern California only 1 percent. This immediately points to a difference in the preven-

tion problem between the two areas. Prevention efforts in the north must take into account a large influx of hunters from other parts of the State. In southern California the hunters are strictly local.

Where Do Hunters Learn About Fire Prevention?—Included in the questionnaire was a list of 12 possible sources of fire prevention information and a space for "other." Hunters were requested to check those sources that they felt had supplied most of their knowledge of fire prevention. Specific sources were listed in order to prevent a repetition of the response to a previous nondirected survey where nearly 70 percent of the respondents listed "common sense" or "experience" as their only source of information. Only 6 percent chose this source in the present survey.

Responses varied somewhat from one part of the State to the other, but in general:

Forest rangers, signs, and Smokey Bear took the first three places.

Television was mentioned twice as often as radio.

Newspapers consistently outrated magazines as a source of fire safety information.

Scouting received much greater mention than schools.

Since the responses represented a mixture of symbols (Smokey Bear), media (television), direct contacts (friends), and unclassifiable sources (experience), it was necessary to cross check the sources by group or cluster analysis. For example, Smokey Bear gets his message to the public through some other media. In this survey Smokey was linked primarily with signs and posters, followed in order by television, newspapers, magazines, and radio.

Comparing mass media with word-of-mouth sources of information showed that the two are nearly equally balanced. Mass media sources received 57 percent of the credit for providing an understanding of fire prevention while word-of-mouth had 43 percent of the responses.

So What?—Although the analysis is far from completed, we already know that there is no single hunter fire prevention problem in California, but a complex of many problems that vary throughout the State. In southern California the hunter is most likely a local resident from the Metropolitan area or its suburbs. A local mass media campaign would probably reach the greatest proportion of these hunters.

In the north end of the State, on the other hand, the average hunter is either a local rural resident or a nonresident from a distant metropolitan area. At the local level, a direct contact before or during the hunting season is the most feasible method of reaching most hunters.

Not only must the prevention approaches be varied to suit the area, but a successful campaign must also take into account age and educational level. As the analysis of data from California's hunter survey continues, we should know more about the kind of information needed by various groups of hunters and the most effective media to reach each group.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustrations. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproductions. Please therefore submit well-drawn tracings instead of prints.


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25th ANNIVERSARY

FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

VOL 23 NO. 1
January 1962

Forest Service
UNITED STATES DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

UNITED STATES DEPARTMENT OF AGRICULTURE 1862 1962

Growth Through Agricultural Progress

Volume 23 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1962

CONTENTS

TWENTY-FIFTH ANNIVERSARY

Fire Control Notes came into being in December 1936 because of the premise that the widely scattered, creative efforts of individuals and separate groups in fire control work could not be fully effective unless they were shared with others. The lead article in that issue, *Fire Control Offers Its Services,* is reprinted here because the purpose and aims expressed in it are as true today as they were 25 years ago.

And in this anniversary issue we have also reprinted *Fire Cooperation in Region 2—the Beginning,* which appeared in January 1937. It is of interest from many standpoints; it is also thought-provoking. After looking back to the early part of the century at the rocky but interesting road of progress in forest fire control, the author observed ". . . no doubt much was accomplished in other regions, but there was a lack of general knowledge among the field men of the various forests as to how results were obtained. . . ." Had it been possible for these pioneers in forest fire control to share their knowledge and experiences other than by infrequent personal contact, progress in the total effort would perhaps be even farther ahead today. Once again Fire Control Notes offers its services.

FIRE CONTROL NOTES OFFERS ITS SERVICES

Roy Headley
Forest Service, Washington, D. C.

The Fire Control Meeting at Spokane, Washington, in February, 1936, gave the Forest Service Division of Fire Control in Washington, D. C., a mandate to issue from time to time a publication which would serve as a medium for exchange of information and ideas between all the groups and individuals who are doing creative work in forest fire control. On the assumption that readers will respond with ideas and information to publish, the mandate is accepted.

Over a period of 30 years since the inception of organized effort to stop the fire waste of American natural resources, impressive advances have been made. Considerable body of knowledge of the arts and sciences involved has accumulated. Systems of organizing and managing human forces and mechanical aids have in some instances attained dramatic efficiency. Fire Research has won the respect of owners and managers of wild land. The advancement to date in technique entitles fire control to a place among the amazing technologies which have grown up in recent decades.

The advance of the technology of forest fire control is not, however, a completed thing. Its forward march has not even begun to slow down. On the contrary, there is good reason to anticipate a period of broader and more rapid growth. Fire control has won a large measure of public interest. Its relation to conservation of wild land resources is better understood. Financial support is increasing. A growing number of men are making technical contributions from a wider range of ability and training. More men know more about how to climb to new plateaus of efficiency in stopping this fire waste.

Future advances will come not from the work of small groups, but from the experience, thinking, and experiments of the large number of men now engaged in pushing back the frontiers of fire control. The integrated experience and study of such a body of interested men may easily yield results overshadowing all that has been gained so far.

The surprising thing is that the need for a vehicle for interchange of ideas among such men has not been recognized before. Widely scattered as they necessarily are, the creative efforts of individuals and separate groups cannot be fully effective without the aid of something which will serve as a common meeting ground, a clearing-house of developments. Fire Control Notes

aspires to render that service. It hopes to be a carrier of whatever men need to know to keep abreast of developments and trends in fire control.

Fire Control Notes will seek to act as a channel through which useful or suggestive information may flow to each man in this field, whether he be a fire research worker attacking some fundamental of combustion, or a fire fighter, facing the flame and smoke, who discovers some new device for organizing a crew of laborers. These pages will also hope to be used as a mouthpiece for every man, whatever his job, who discovers something which would be useful to others, or who has a criticism to make, a question to raise, or an unusual fire experience to relate.

As implied by the name, "Fire Control Notes," it matters not how long or how short a contribution may be nor what angle of fire control is presented. The man who discovers some new device which can be presented in four lines owes it to himself and others to report it. Likewise, the fire research man who needs ten pages for a worthwhile presentation of his subject should share what he has learned with others who need his help or who may be needed to supply the intelligent interest required to sustain the inquiry.

The only requirement imposed upon contributions to Fire Control Notes is that they be interesting or helpful to some group of people concerned with some phase of fire control.

FIRE COOPERATION IN REGION 2—THE BEGINNING

JOHN McLAREN
Liaison Officer, Sixth Corps Area

For many years prior to the creation of the National Forests in Colorado, I lived in Pitkin County in wooded areas which later became part of the Holy Cross National Forest. In the fall during those years one could see smoke from unattended fires at almost any point of the compass, and naturally Colorado suffered enormous timber losses, for conditions in my locality were not materially different than in other sections of the State, as I afterward learned.

The Holy Cross and other Colorado Forests were placed under administration in 1905 and 1906, and an extremely limited field force was kept busy long hours each day trying to keep up with marking and scaling timber, and fire control was about the only interruption tolerated. From the beginning, however, all forest officers were impressed with the fact that they must be on the alert to prevent fire damage, and necessarily must act promptly if fires were to be suppressed.

Foresters coming into the service today can have no conception of the situation faced in those early years, for there was an almost universal antagonism from every quarter toward forest administration, and some of it was very bitter. Timber operators and grazing men were sure their individual rights were being jeopardized, and others were "agin" it because it was something new and they were not sure it would be of benefit, so preferred to let the old order ride.

This drab outlook faced a ranger when he found it necessary to tackle a fire. Perforce he must get as many men as possible as fire fighters from any and all walks of life, and "please each man bring his own ax or shovel," for those days preceded the era of fire tool caches, telephone lines, automobiles, truck trails, and lookout systems.

Most of the old timers in field service in those days have been replaced by men with more education and nimbler typewriter fingers, but my hat is off to that advance guard that had the hardihood to stick with and worry at the job in the face of the discouraging outlook; and boys, did that bunch do an excellent public relations job, though the term did not come into usage until some years later. Strangely enough, doggedness and perseverance in fire work seemed to be the opening wedge in getting public confidence, and after a while there was a sort of grudging

admission that it did really seem possible to check and whip a fire with man-power, and the efforts of the field men began to bring some praise.

Thus it became apparent that fire publicity was the best means at hand to arouse public interest in the Service and its aims and policies. Fire suppression jobs were publicized in the newspapers, and particular effort was made to give credit to civilians who took part in the work either of detection or suppression. Stress was laid on the need for eliminating fire from the ranges in the interest of stockmen; on the fact that timber must be free of fire in the interest of loggers and lumbermen, and that success in the mining industry depended a great deal upon the elimination of fire. Furthermore, if returns to the counties from the 25 per cent fund were to be worth while and maintained, the resources must be kept free of fire damage. Naturally, individual selfish interests were played upon: Farmers might be bankrupt through the loss of their improvements and the reduced fertility of the soil; a mining operation might be stopped by fire through loss of surface buildings and the necessary timber; and, too, many towns and settlements might be wiped out, with loss of life.

I have been asked how our system of fire cooperation got started. The foregoing indicates something of the way in which the start was made. As to when and where it started, I cannot say. In all probability field men were doing the same thing simultaneously on all forests. Apparently the first universal step was to interest people in detection work. "Keep a sharp lookout for fires and make prompt report to the nearest forest office." As I recall, my first personal attempt along this line was to line up teamsters hauling lumber and logs into Norrie to report railroad fires.

Logging operations were confined largely to the mountainous slopes south of the Frying Pan River, while the Colorado Midland Railroad wound a tortuous route along the mountain slopes north of the river. Only a few miles of right-of-way could be sighted from the ranger station, but the teamsters had a panoramic view of the entire railroad, so they could and did watch for fires and report them. Among those lined up to scan large areas under their immediate control were a resort owner, a mine superintendent, and a German farmer. The latter was a valuable find, for he was German born, had a very intimate knowledge of German forests and forestry practices, and was inordinately proud of having a connection, even without pay, with the U. S. Forest Service in the capacity of a fire guard. He was so enthusiastic and so willing that in a very short time fire tools were placed in his barn, and he was given authority to take direct charge of any fire in his territory and to employ fire fighters as needed.

Even after a few lookouts were manned, the public was requested to see how many times they could beat the lookout observer in reporting fires, and they gleefully responded. This voluntary service was extended year after year until there was a very large number of individuals who could be depended upon

for detection and a smaller number who were entrusted to take initial action and incur expense in fire suppression. Let me repeat that this was not the only territory where progress was being made. No doubt much was accomplished in other regions, but there was a lack of general knowledge among the field men of the various forests as to how results were obtained, and such information as was obtained came largely from inspectors of the Regional Office at infrequent intervals and at rangers and supervisors' meetings.

When the Regional Office established the position of Fire Chief, a survey disclosed that while excellent progress had been made in rousing the public to be fire-minded and co-operative, it was very spotted even as to individual forests: There was a lack of standardization in fire tools both as to kind and number, and the majority of the fire plans were of the old narrative type—too voluminous and bulky to be of much value even to the men who made them. Fire tools were standardized rapidly, and Region One's Fire Organization Chart was adopted in modified form.

Effort was immediately centered on convincing each and every field man of the importance of enlisting dependable public cooperation. This, by the way, was not accomplished in a season. Eventually it did exist well toward 100 per cent as a mass consciousness from the newest member of the force, through the Supervisor's office to the Regional office, to the Regional Forester himself. There was an essential objective, for mass effort produces mass results. The chart referred to became the fire plan for each ranger district, and responsible citizens at strategic points were listed as keymen. These were men who were, and are, called on to drop their private work and devote time and energy to public interests. These plans were frequently inspected and checked in the field to insure that they were not paper plans only.

The methods employed were many and varied, and depended upon the initiative of individual forest officers and the individuals to be worked on. In general terms: "We are a skeleton force willing and anxious to do everything possible to protect the resources, but you are the owners of these forests—the stockholders in this concern—and without your whole-hearted interest and action we must fall short of the success otherwise possible."

Each forest officer must believe whole-heartedly in the worth of converting apathetic or indifferent individuals and communities to an active sense of duty in fire control—it can be done. The forest ranger has better chance for success than others, for he personally knows the people in his territory, has a knowledge of their personal interests and their idiosyncrasies, and therefore has the best approach.

TRAINING FIRE PROFESSIONALS[1]

MERLE S. LOWDEN
Director, Division of Fire Control, U.S. Forest Service

Training of professional firemen for forest fire control work has received increased attention in recent years. There is general recognition that this training is not of the quality nor in sufficient amount in most cases to do a fully satisfactory job of providing qualified personnel needed for this important job. Such training has lacked stature, financing, and the necessary interest of some administrators in the past. There are encouraging signs, however, that forest fire control training is to get increased attention and a more prominent place in the entire fire control job. My remarks on this important subject will relate most specifically to the work of the U.S. Forest Service, but the job to be done is quite similar on areas protected by the States, other Federal agencies, and private organizations.

Forest fire control involves the protection of valuable resources, is often costly, and is highly technical and important work. It requires skilled personnel who know their jobs. Decisions of supervisory personnel must be made quickly and must be right. A wrong decision may be costly in fire fighting costs, expensive in lost resources, and tragic as it concerns the lives of participants and others in the area.

All training work should start with an analysis of training needs. This in reality is the difference between total needs of capable personnel to do the needed job and those currently on hand and capable to do the work. In fire control this means determining the number of men we need for lookouts, patrolmen, smokechasers, fire bosses, plans chiefs, supply chiefs, and the many other specific positions we have to do our fire job. In the suppression organization we have specific positions. From analysis and with our qualification system, which I will describe later, we then determine the number of employees we have qualified for each position. The difference is the number to be trained. However, this is an oversimplification as some only need refresher work and others need all the fundamentals. Of course before we figure our training needs we have a plan for the desired fire control jobs which is modified to fit the money available. As you all know whether in government or in private industry, we must match the organization to the budget.

Fire control training can be divided into the three main categories of the job itself; i.e., prevention, presuppression or preparation and suppression or the actual fighting of a fire. From my experience I have noticed most attention in training is given to preparing men for fire fighting with usually decreasing attention to training for preparedness and prevention. The latter is begin-

[1]Presented to the National Academy of Sciences, National Research Council, Woods Hole, Mass., July 21, 1961.

ning to get more attention and the outlook is that prevention training will receive more deserved recognition in the future.

The Federal Forest Service requires training for four groups of personnel and their various needs must be recognized in the training program. The first group includes the full-time fire control professional who devotes all or practically all of his working time to fire activities. Next is the professional forester or other full-time employee who devotes only part of his time to fire work either regularly or as called upon in an emergency to help on a suppression job. Men with fire work as part of their normal duties may work on one or several multiple-use land management functions the balance of their time. These folks cannot be expected to know as much or be as skilled in the fire job as the full-time fireman. In addition to yearlong employees the Forest Service and most other forestry agencies employ many for seasonal work. Some seasonal employees are primarily fire employees working on such jobs as lookouts, crewmen, smokejumpers, dispatchers, and patrolmen. Other seasonal employees such as laborers, truck drivers, packers, and machine operators may work on construction or maintenance jobs or other work most of the time but are available for fire work when needed.

Our full-time fire employees are either foresters or professionals in related fields or employees who have come up through the ranks from seasonal fire employees. One might think that graduates from an accredited forestry school would have received fire control training as part of their undergraduate work, but usually they get very little such work in college. Most often they have had only one course in protection which may have included pest control as part of the course. One full fire course, or two fire courses at the most, is all a forester now gets in college. The work is usually more of an orientation to fire control and not of immediate application. However, often forestry graduates have worked on seasonal fire control jobs during their vacations while in college and have received much valuable training and experience in this manner. Most of our present fire leaders worked on vacation fire jobs during their college days, and in the process, received many fire fundamentals.

Apprenticeship or understudying is a common method for fire control and other personnel to advance in the Forest Service. Many nonprofessional fire employees are classed as technicians and through experience and training can advance to responsible positions in fire control. At the lower grades there is less distinction between professionals and technicians in training given. In the Forest Service we are establishing training standards which, as they are refined and fully adopted, will require that men receive and pass certain specific fire control courses of increasing complexity in order to advance from one grade to another. We have a big job to get these standards fully defined and operating but I'm sure they will mean better qualified men and improve the performance in our fire work in the future.

In addition to these standards for Civil Service grades we have a qualification program that applies to men in fire suppression

supervisory positions. Each of our regular men qualified for a fire overhead position has a "red" card which designates the position or positions which he can handle and those in which he needs training. A qualified sector boss may be listed as needing training as a division boss or as a camp manager. Minimum standards have been established for the top positions on a national basis and for the lower positions on a regional basis. A Class I fire boss or fire general, for example, must have passed qualified fire behavior and fire generalship courses, must be a thoroughly qualified Class I line boss, must have had current experience (within 3 years) on Class C or larger fires and experience on a total of at least 30 fires, including 10 Class E fires (over 300 acres).

Our fire training is given at national, regional, or local schools depending on the level of instruction, the number to be trained, and other considerations (fig. 1). Local fire schools on ranger districts or forests have been held for many years and many of our regions have given training in more advanced courses.

The annual fireman school is a tradition on most national forests and is a practice followed by many States. These sessions often run for 3 to 5 days and train men in such jobs as detection, smokechasing, suppressing small fires, operating machinery, fire prevention, law enforcement, and safety. Such specific skills are taught as map reading, "running" a compass, operating a fire finder, building a fireline, and similar doing jobs. These schools serve to orient many new employees and are good morale builders. Regular full-time employees mingle and work with seasonal trainees and prepare for the teamwork needed in the fire season ahead Fireman schools haven't changed greatly through the years except more training aids are used and subjects such as air operations and fire behavior have been added. The emphasis is on real work and the men are given a chance to demonstrate what they have learned by doing the jobs in most cases. Often seasonal employees working in other activities are included to train needed replacements or to give these employees selected training in such subjects as fire fighting.

Increased attention is being given to training through special assignment; that is, training in place by working at some location other than the usual assigned station. Men are detailed to other offices or locations to do preparedness or prevention jobs or to going fires in other forests or regions. Training on fires may be as apprentice or understudy to a regular position, or part of the time may be spent in a regular organized group receiving planned training on the fire. At the national level we have been featuring interregional details for training and last year nearly 150 men received training in this manner. We have encouraged our regional officers to detail men between forests for suppression training on fires. We have trained a great many men in our Washington office by detailing them in to do specific jobs. This method has great possibilities but must be well planned, aimed at specific objectives, and carefully supervised.

FIGURE 1.—Trainees and instructors, Fire Behavior Training Meeting, Alexandria, La.

Within the past 4 years we have conducted several national courses in advanced fire work and we intend to have more. Because we had recognized an urgent need to increase knowledge in fire behavior we have had three national schools in this work of 3 or 4 weeks' duration. These schools were aimed at training men to be fire behavior officers on fires, providing training materials for additional training, and training men who could serve as trainers for others in the field. This last objective has been especially fruitful and thousands of our men as well as State and Department of the Interior employees have had fire behavior training of varied intensity and amount. We have also had courses in fire generalship and air operations in national schools. Fire personne from State forestry organizations and the Department of the Interior have been trainees at the national courses and we plan to continue this practice.

Our regional schools are usually aimed at training for fire suppression overhead positions. Their length varies depending on number of subjects covered and experience of the men. In recent years these courses have featured tactical support in service of supply, plans, and finance subjects. Generally a more well-rounded program is emerging although we recognize deficiencies in both quality and quantity of training in various subjects and locations.

Although not in practice but on the immediate horizon is advanced university training of selected individuals for careers in fire control. We have selected several individuals this year for this training under the national training act which permits the Government to finance this training. They will be given some choice in their advanced work under general guides. We hope their specialties will vary but we want them to have general objectives. Arrangements for such advanced work have been made at Yale and the University of California.

At the national level we have underway several projects to improve our training program. Training is high priority work since it involves so many people and is so vital to success of our entire fire control efforts.

Simulation is the watchword in training these days and we have endeavored to utilize its advantages as far as we could. A special project on simulation has been underway about a year and we are near a contract with a leading development company for a completed training problem and related equipment. We have had some men attend national seminars and work conferences in simulation such as that in management conducted by the American Management Association. The principles of simulation have long been applied in our fireman schools, in national courses, and at other fire training, but we know there are many opportunities to do more of it.

Closely related to this simulation work is the use of training machines in our training. The opportunities in this field look particularly promising. Self training has always been a strong part of our program but with training machines we can apply the best techniques, teachers, and methods to individual learning.

We have leaders in this field assisting us in getting this program started and the outlook is particularly good, especially in certain fields of study.

As a strong base for training we recognize the need for basic instructional material. Our national Fire Control Handbook and specific guides such as the Fireman's Guide, Air Tanker Guide, and Air Operation Handbook are examples of fundamental material on how, when, and where to do fire jobs. We also have a national project to develop training films to aid local training efforts. Several films have been completed recently and are in widespread use. Others are in the planning or making stage. We recognize a film is merely an aid and part of a total program for any subject. Some films are aimed at general orientation and others are more specific on "how to do" jobs.

Looking ahead there are many things we plan or hope to do on training. Training machines, simulation, films, and other aids may be made better and more specifically devoted to accomplish defined objectives. We need better facilities in training centers. These are being developed now at regional and interregional locations. For many years the proposal for a national fire institute has been discussed. Finances have been one strong deterrent. The idea of a national training center for forest fire control is very intriguing and likely we'll have a facility arrangement for special advanced training for fire leaders. I'm sure, too, we'll tie more closely to universities in this work. They have facilities and discipline capabilities of many types that could not reasonably be assembled any place else. They should be able to arrange specific courses for the particular needs of fire organizations. The forthcoming staff and command school to be held by the Office of Civil and Defense Mobilization for both rural and urban firemen is a great opportunity to get underway advanced fire instructions for all fire leaders.

Not strictly training but closely allied to it is the problem of selecting the right people for fire control careers. Little has been done on this in our field and we recognize the deficiency. We are making a start in it in selecting smokejumpers, but this is not on the major problem. Those not capable of becoming good fire men or with the wrong mental attitudes must be taken out before we apply expensive training. From what my urban fire friends tell me I understand they have done much more on this than we have We also need to analyze jobs more thoroughly to know just what men in certain positions do and how well they do it. Because of the importance of the position we are making a study of our crewboss who is the key leader of men in our suppression organization. We know these men are not always as strong as they should be, but we need to know more about how they perform. what they know, how best to select and train them, and similar requisites.

The fire training outlook is encouraging. New techniques, new aids, different ideas, more funds, greater recognition of training, and the general demand for better fire control, all point to better forest fire control training in the future.

FIRE WHIRLWINDS IN THE LABORATORY

GEORGE M. BYRAM, *Physicist*, and ROBERT E. MARTIN, *Research Forester, Southeastern Forest Experiment Station*

Most experienced firefighters have encountered fire whirlwinds. These whirls, or "fire devils" as they are sometimes called, range in size from small twisters a foot or two in diameter up to violent whirls equal to small tornadoes in size and intensity. Graham[1] gives examples where tornado-like fire whirls have twisted off large trees and lifted large logs. Whirlwinds have also occurred on urban fires. In his account of the great Chicago fire of 1871, Musham[2] states that burning planks were lifted by fire whirlwinds and dropped as far as three-eighths of a mile ahead of the main fire. He attributes a large part of the destruction of the city to burning material carried by the fire whirlwinds.

Because of their importance as a hazard to firefighters and as a cause of rapid and erratic fire spread, fire whirlwinds are one of the fire hehavior phenomena being studied at the Southern Forest Fire Laboratory at Macon, Ga. These whirlwinds can be produced readily on a small scale and studied by modeling techniques.

In the past miniature whirlwinds have been produced in several different ways. In some of these there was no heat source. In others steam or heated water vapor has been used as a heat source. Usually the initial cylinder or cell of gently rotating air was produced by a blower or fan. However, a thermally driven whirlwind appears to work equally well and has the advantage of being partially self-regulating.

Chambers for producing thermally driven fire whirlwinds on a model scale are shown in figure 1. The large chamber on the right consists of a cylindrical shell 26 inches in diameter and 72 inches high over which is mounted a truncated conical shell 60 inches in height. The cone tapers from a base 26 inches in diameter to a top 13 inches in diameter. The front half of the cylinder is transparent plastic; the rear half of the cylinder and the cone are fabricated from poster board. Air enters the chamber through two ¼-inch tangential slits located on opposite sides

[1]Graham, Howard E. A fire whirlwind of tornadic violence. Fire Control Notes 13(2) : 22-24, illus. 1952. *Also*, Fire whirlwind formation as favored by topography and upper winds. Fire Control Notes 18(1) : 20-24, illus. 1957.

[2]Musham, H. A. The great Chicago fire. Papers in Illinois State History and Transaction for the year 1940; The Illinois Historical Society, Springfield, Ill., 69-189, illus. 1941.

FIGURE 1.—Two sizes of fire whirlwind chambers of slightly different design. The large chamber on the right can produce whirls up to 11 feet in height. The small chamber on the left forms whirls from 15 inches to 36 inches in height.

of the cylindrical section, producing a gentle rotation of the air inside. The heat source is a pool of burning alcohol 4.8 inches in diameter and ½ inch deep located on the vertical axis of the cylinder. Its rate of heat output is about 11 B.t.u. per second, or slightly less than half the output of an average oil house furnace.

The small chamber in figure 1 was built as a portable demonstration chamber. It has an all-plastic transparent cylinder 15 inches in diameter with one tangential air entrance slit. The conical section is thin cardboard and tapers from a base 15 inches in diameter to a top 8 inches in diameter. Both the cylinder and the cone are 3 feet in length. For portability the cone can be inverted and placed inside the cylinder. Depending on the size of the burning alcohol pool, it can produce whirlwinds from about 15 to 36 inches in height. Those more than 25 inches in height show most of the features that can be seen in the whirlwinds in the larger chamber.

After the alcohol is ignited in the large chamber, the whirl forms in 20 or 30 seconds. At first the alcohol pool burns with a lazy flame. As the heated air rises and cool air flows tangentially into the chamber, the flame becomes tilted in the form of a curved arm which slowly rotates around the pan. The tip of this flame then curls back on itself and begins to spiral upward, forming the base of a crude, off-center vortex which finally stabilizes over the center of the alcohol pool. The whirl is then visible to a height of 3 or 4 feet (fig. 2), with a smooth inner column surrounded by strands of flame spiraling upward. The whirl gradually lengthens and becomes thinner. In the fully developed whirlwind, the average diameter of the inner tubelike column is about three-fourths of an inch and is visible to a height of 9 or 10 feet. At this stage the smooth inner column, which corresponds to the funnel of a tornado, constitutes most of the fire whirlwind (fig. 3). The outer spiraling flames form a column about 1.6 inches in diameter and are visible to a height of about 18 inches above the burning pool, as shown in figure 4.

For its size, the model whirlwind appears to generate a very high velocity in the hot gases spiraling upwards. This velocity has a horizontal component which creates the spin or rotation, and a vertical component, or updraft, which carries the heat from the burning fuel upwards. Although they will have to be verified by direct measurement, approximate values of these velocity components can be calculated from the energy equations using the temperature and dimensions of the whirl. The horizontal component comes out to be about 20 or 25 miles per hour at the surface of the inner column, which would give it a rotation of about 6,000 or 7,000 revolutions per minute. More surprising, and possibly more significant from the fire behavior standpoint of full-scale whirls, is the probable high updraft velocity, which has a computed value of about 40 or 50 miles per hour. If an updraft on a full-scale whirl had a velocity of five times this

FIGURE 2.—A fire whirlwind in the large chamber in its early stages of formation. A tube or tornado funnel has started to form inside the whirl near its base.

FIGURE 3.—The visible part of the fully developed whirlwind consists mostly of the smooth central column or tube, which has a very high rate of rotation.

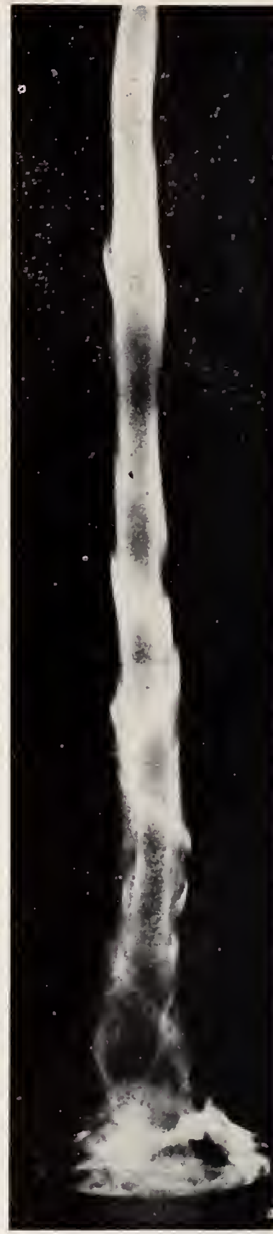

FIGURE 4.—A closeup of the lower part of the fully developed fire whirlwind showing the strands of flame spiraling upward around the central tube.

value, it would explain the lifting capacity of the fire whirlwinds described by Graham and Musham.

Another significant feature of the model whirlwind from the fire behavior standpoint is a sudden three-fold increase in the alcoho burning rate when the whirl forms. It is possible that a marked increase in burning rate also occurs in forest fuels when whirlwinds develop.

The principal value of model whirlwinds, and other types of convection models, is in the detailed study of their physical structures and dynamic characteristics (such as vertical and horizontal velocities). Through the application of scaling laws a better understanding of the cause and behavior of the full-scale phenomenon should be possible.

TESTING AND EVALUATING CHEMICAL FIRE RETARDANTS IN THE LABORATORY[1]

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Western fire control agencies dropped 7 million gallons of fire retardant mixtures from aircraft in 1960. They are continuing aircraft drops in 1961 and are testing both retardants and suppressants in fire trucks. It is not surprising that firefighters have expressed considerable interest in learning how new materials are selected for trial on actual fires. This paper describes the first steps in the process of seeking new or improved materials and the laboratory methods used in this preliminary screening. Subsequent steps include small-scale field trials on forest and range fuels and then operational tests on wildfires.

Before any new material can be tested by field or operational trials, a great amount of factual information is required. For example, the men in charge of forest firefighting will need to know if ample supplies will be readily available; what the material will cost; whether special techniques will be needed in mixing, handling and storage; and if the mixture could damage equipment or endanger personnel. Firefighters will also want specific answers to the following questions:

1. Are high temperatures or other chemicals required to obtain applicable mixtures?
2. How will the retardant mixture be affected by the acidity or alkalinity and hardness of the water to be used?
3. Does the material adhere well to fuels when first applied?
4. Does the coating tend to crack or crumble under extreme drying conditions?
5. Is the material sufficiently slippery to constitute a hazard to men working around fire trucks or aircraft?

Much of this information can be obtained from brochures of suppliers or through correspondence with the manufacturer. For some of the questions, however, specific answers must be obtained by laboratory evaluation.

PHYSICAL AND CHEMICAL PROPERTIES

Mixing

Simple tests will show whether the product is readily soluble in hot or cold water and whether it requires mixing by rapid agitation or by injector-type mixers. The effect of the acidity or alkalinity and the hardness of the water on the test mixture can be observed at the same time. When available, the manufac-

[1]Issued Aug. 1961 as Pacific Southwest Forest and Range Expt. Sta. Misc. Paper 59; original paper included illustrations and list of references.

turer's recommendations are very helpful in determining the best method of making a solution of the proper viscosity. A sample of the mixture is placed in a beaker and its viscosity recorded at room temperature with a Brookfield viscometer.

Stability

Fire retardants to be used by initial-attack aircraft or ground tankers often have to be mixed and stored in advance of anticipated use. To determine stability of stored mixtures, a beaker sample is placed in an oven maintained at 80°F., and viscosity is measured after 24, 48, 168, and 720 hours. The mixture is checked to see if the retardant has tended to separate or has remained in solution, if evaporation has been excessive, or if bacteria have caused spoilage. To prevent spoilage, a preservative may have to be added to the mixture.

Corrosiveness

The corrosive action of a fire retardant on metal parts of fire equipment, such as hose connections, pumps, and storage facilities, may definitely restrict its use. The increased use of air tankers makes it doubly important that corrosive effects of retardants on aircraft parts be known and eliminated, because of the danger to operating personnel and the high upkeep costs of the aircraft. Therefore, suggested retardants are subjected to two types of corrosion tests.

One type is a "static" test conducted according to the method outlined in J. H. Perry's *Chemical Engineering Handbook*. The metals used in these tests are copper, brass, bronze, mild steel, aluminum, and magnesium. Test samples 0.025 inch to 0.075 inch thick are cut into 1- by 2-inch rectangles before submersion; they are lightly polished on a buffing wheel to remove scratches and toolmarks, washed in a solvent to remove any oil film, and dried. The retardant to be tested is placed in 250 cc. beakers and allowed to stabilize for 1 hour at room temperature. A sample of each test metal is then placed in a beaker with the retardant for 5 days. Each test piece is weighed to the nearest 0.1 milligram on a precision balance before and after the test. The weight loss is calculated in milligrams per square decimeter per day.

The second type of test simulates field conditions in which the metals are not only exposed to the chemicals, but to the air as well, or they are alternately exposed to chemical and air. Materials for this "dynamic" test are prepared as for the static test, but the test pieces are suspended from a shaft rotating at 1 r.p.m. so that they are alternately submerged and then exposed to the air for about 30 seconds. This cycle is continued for 72 hours. In both the dynamic and static procedures each test is repeated from two to five times.

Fire Retardant Effectiveness

Three test procedures are used to evaluate fire retardant effectiveness. Two of these tests are relatively simple procedures used to measure resistance to ignition and reduction in combustion

rate. The third, called the "steady-state fire model technique," is somewhat more time consuming, but more nearly simulates fire spread through vegetation. It is usually reserved for those materials showing the most promise in ignition and combustion tests. It should be emphasized that these tests are part of a screening process. They make it possible to determine which materials should be evaluated in the field, but they are not a substitute for field evaluation.

Ignition Test

Resistance to ignition is determined by measuring the time required for treated and untreated maple dowels to burst into flame when placed in a muffle furnace. Sixty-four maple dowels, $\frac{1}{4}$ inch in diameter by $5\frac{1}{2}$ inches in length, are prepared for a single test. Eight of them are sawed into quarter-inch lengths for fuel moisture determination by the xylene distillation method. One set of six dowels is reserved as control samples. Five sets of 10 each are used for the ignition test.

All six sets are clamped upright into aluminum holders, placed in a drying oven, and held in circulating air at 115° F. for 24 hours. After drying, the control set is weighed, all sets are dipped 5 inches deep in the retardant to be tested, and the control set is again weighed. All six sets are then placed in the drying oven. The time is recorded. At the end of 1 hour, the control set is again weighed and returned to the oven, and a set of 10 dowels is removed for the ignition test. This procedure is repeated at hourly intervals through 5 hours.

For the ignition test, the dowels are placed one at a time in a holder and inserted in the muffle furnace. The time elapsing before a burst of flame is measured by a stopwatch, and this ignition time for the 10 dowels is averaged.

The control set is kept in the drying oven 24 hours and then weighed. This set provides a record of the amount of retardant and water adhering to the fuel, the water loss each hour for 5 hours, and the amount of retardant adhering to each dowel after 24 hours of drying.

This same test may be made with plain, untreated dowels and with dowels dipped in water, as a basis for future comparisons if required. The test may also be made for different furnace temperatures, usually from 1,000° to 1,700° F. at 100° intervals.

Combustion Test

The ability of a retardant to slow or inhibit combustion is determined by burning treated dowels and recording the resulting radiation intensity and weight loss.

Weight loss is measured with a 5-kilogram laboratory scale. The scale is equipped with an aluminum frame clamped to the side of its main platform. This frame supports a horizontal, slotted metal strip from which the test dowels are hung with a half-inch intervening air space between each. A pan beneath the dowels collects falling ash or charcoal. A Gier and Dunkle

radiometer is placed 9 feet horizontal distance from the fire, and the radiation intensity is registered by a recording potentiometer.

Each test requires four untreated and three retardant-treated ponderosa pine dowels ½ inch in diameter and 7.5 inches long. The untreated dowels produce the heat required to burn the three treated ones with which they alternate on the slotted strip. Each dowel is hung by a small wire brad driven into one end.

Forty-one dowels are needed to test each retardant mixture. They are conditioned 24 hours in the drying oven to approach equilibrium moisture content. Six dowels in a special holder are used as a weight control. The tare weight of the holder is determined, as is the weight of the six dowels. These dowels, together with five other sets of three each, are then dipped in the retardant to be tested, and the weight of the control set is again recorded. All are then replaced in the oven for drying. At the end of each hour of drying time, the special holder of six is weighed to determine the water loss, and three treated dowels are removed from the oven and suspended from the scale in positions 2, 4, and 6 on the slotted strip of metal. Four untreated dowels are hung in the 1, 3, 5, and 7 positions.

A horizontal asbestos wick containing 6.7 cc. of ethyl alcohol directly below the dowels is ignited; at the same time the weight is recorded from the scale and a stopwatch is activated. Every 30 seconds the scale reading is recorded. These readings show the loss of fuel weight due to combustion, while the chart connected to the radiometer registers the radiant heat produced by the combustion.

These records show the comparative effectiveness of various retardants. Some retardants may slow down the combustion process in the treated dowels; others may prevent combustion. The test is repeated at hourly intervals to show the ability of a retardant to remain effective after different drying periods.

Steady-State Technique

In the steady-state test, the rate of spread, the radiant energy, and the convective heat of a fire burning in an untreated portion of a crib of ½-inch dowels are compared with measurements obtained when the fire burns into the retardant-treated part of the same crib.

The fuel for this test is a crib built of 6 tiers of 21 dowels 7.5 inches long and 6 tiers of 5 dowels 35.5 inches long. These dowels are half-inch-round ponderosa pine. They are placed in a jig, glued with small drops of resin, kept under pressure overnight, and subsequently conditioned in the drying oven for 24 hours at 115° F.

The crib is removed from the oven and weighed. One end is dipped 12 inches into the test retardant and then allowed to drain for 5 minutes. It is again weighed to determine the amount of retardant and water adhering, and replaced in the oven for a specified time (1 to 24 hours). It is then weighed again and placed on the movable center strip of the fire table.

The untreated end (in line with the eyes of the operator) is ignited with an asbestos wick containing 6.7 cc. of ethyl alcohol. As the crib is consumed, the operator cranks the fire "front" forward to keep it in a steady position before him, recording the number of revolutions he has turned the crank each minute. A Gier and Dunkle radiometer, which is aimed at the fire and mounted at a horizontal distance of 14 feet, records the radiant energy on a recording potentiometer. The 2 feet of untreated fuel bed gives the fire a chance to reach a "steady state" before reaching the retardant. After this, the drop in intensity and rate of spread, as graphically represented on the recorder charts, forms a basis for comparison between retardants.

In all tests using wood dowels or cribs, the moisture content of forest fuels is determined by xylene distillation and considered in the analysis of the results.

BOY SCOUTS USE HERBICIDES IN FOREST FIRE CONTROL PROGRAM

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Director of Conservation, Rodney Scout Reservation, North East, Maryland

Since World War II there has been considerable use of herbicides in controlling vegetation, notably along rights-of-way and roadsides. These herbicides have also been used in controlling unpalatable and poisonous plants on the western ranges and deciduous woody vegetation in coniferous forests.

In certain forest regions, breaks of low, stable, relatively nonflammable vegetation are important in a fire control program. In times of emergency such breaks serve for access by foot or jeep and as a base from which to start backfires. Since 1957 breaks of this type have been part of a research and demonstration project in the Conservation Program at the Rodney Scout Reservation, North East, Cecil County, Maryland.

Soil erosion can become a serious problem on these breaks if all vegetation is killed. This is especially true in the southeastern Coastal Plain, and is particularly true at the Rodney Scout Reservation. On such areas a cover of low nonflammable vegetation is needed to stabilize the soil and prevent erosion.

Early Practices not Satisfactory

In recognition of the fire hazard, several firebreaks had been constructed on the 1,050-acre Scout reservation prior to the start of this program. These breaks included not only strips along roadsides and electric powerlines, but also several breaks constructed solely for fire safety purposes. The procedure had been one of cutting and felling the trees, piling branches in large brush piles at a safe distance from the fire break, and rolling the logs to the side. Vigorous resprouting of the forest trees made maintenance of these vegetation breaks a continuing and costly job. For these reasons it was decided to use herbicides to control the vegetation.

Basal Sprays Kill Unwanted Trees

The herbicides used were 2,4-D (2,4-dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) mixed with kerosene in the ratio of one part commercial herbicide to 25-50 parts kerosene (or fuel oil). They were sprayed on the bases

[1]The program reported here was suggested by Mr. Ted S. Pettit, National Director of Conservation, Boy Scouts of America. Valuable guidance and assistance was received from Dr. Frank E. Egler, Consultant for the Vegetation Management Program at the Rodney Scout Reservation.

FIGURE 1.—*Top*, Diagrammatic representation of cross section of unsprayed trail showing tree saplings and stump sprouts among shrubs. *Middle*, Same cross section one year after spraying showing death of unwanted trees. *Bottom*, Three years after spraying showing closing of shrub canopy.

of the trees with specially adapted backpack sprayers. Great care was taken to spray only the unwanted tree sprouts and saplings. In new breaks, the stumps of the larger trees are being sprayed soon after cutting, thus eliminating the more costly work of spraying the sprouts a year or two later.

All desirable shrubs such as blueberry, huckleberry, azalea, and male-berry were left unsprayed so that they would grow and form a closed canopy to retard the establishment and growth of tree seedlings (fig. 1).

The powerline vegetation break at Rodney (fig. 2) was constructed in 1955. Part of its vegetation has been under yearly herbicide treatment since 1957 by Scouts working on conservation merit badges. Inadequate spraying and misses were high at the beginning because of untrained Scout assistance. Vigorous sprouting from large oak stumps and excessive rootsuckering from sassafras caused conditions which would not have occurred had adequate spraying followed the original clearing of the break in 1955. Each successive spraying, however, reduced the number of surviving unwanted woody plants and allowed the shrub canopy to close. And most important, *no reinvasion of unwanted*

FIGURE 2.—Powerline vegetation break during August 1959. Note the almost complete closing of the shrub canopy, which retards growth of tree seedlings. The shrubs in the foreground are sweet pepperbush (*Clethra alnifolia*). In the background are blueberries, huckleberries, male-berries, and azaleas. (Photo by J. Bazzoli.)

woody plants is occurring! No spraying will be required for at least 5 or 10 years.

Reinvasion of Woody Species is Low

The soundness of the selective herbicide treatment lies in the relative stability of pure shrub cover. The inability of trees to invade pure stands of shrubs is well known to foresters dealing with the hazel thickets of the Lake States and the rhododendron thickets of the southern Appalachians. The rhododendron balds in the latter areas have been surviving since Indian times.

The application of these principles for firebreaks is reported in another Scout project[2] at the Ten Mile River Scout Camps, Sullivan County, New York. In this area, a stable low vegetation was accidentally developed in one small part of a 40-mile boundary firebreak following the cessation of CCC activities in 1936. This stable vegetation, of a type that can now be purposely constructed by selective spraying, *has already lasted for 25 years* without one dollar being spent upon it, nor have any unwanted trees yet invaded it!

[2]Pound, C. E., and Egler, F. E. Brush Control in Southeastern New York: Fifteen Years of Stable Tree-less Communities. Ecology 34: 63-73. 1953.

A DYNAMIC TRAINING EXERCISE FOR SUPPRESSION CREWS

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Assistant Fire Control Officer, Angeles National Forest

There is need for new training approaches to meet the increasingly specialized and difficult fire training job. A dynamic "battle"-type exercise for all categories of fire suppression crews offers many challenges to trainees. To be fully effective, such an exercise must fit the needs of the large-fire suppression crew and many types of initial attack crews.

A particularly perplexing training problem facing many national forests is the followup or maintenance training of initial attack crews. For example, the Angeles National Forest in southern California has a sizable training program for its 22 five-man ground tanker crews. It needed an inexpensive exercise that would require participation by all crew members, stimulate their interest and thinking, force leadership by the crew boss, and be simple and easy to operate.

A fireline game designed to meet these criteria was used by tanker crews on the Angeles during July and August 1961 (fig. 1). Without exception, crew foreman and crew members remarked that this exercise added much to their training and helped to maintain a high degree of interest. The original exercise was expanded and further refined by the foremen during the summer.

The game requires:

1. A magnetic board (about 2 by 3 feet) with a drawing of a small fire whose perimeter is marked off into 20 equal parts, or 20 chains.
2. A colored magnetic marker for each player (or team).
3. A set of practical problems of varying levels of difficulty from 1 chain (easy problem) to 4 chains (difficult problem). These problems are the key to the success of the exercise.
4. A game manager, i.e., crew foreman.
5. Individual players (or teams), i.e., crew members.

Rules for playing the game (to be explained by game manager before starting):

1. Each player (or team) is assigned a colored magnetic marker.
2. The players (or teams) draw for starting positions.
3. The game manager records the order of players.
4. All markers are placed at the initial attack position, marked X.

FIGURE 1.—Tanker foreman exercising two tanker crews with fireline game, and a single crew indoors.

5. The game manager asks the first player whether he wants a 1-, 2-, 3-, or 4-chain problem.

6. The first player (or team) then chooses a problem.

7. The problem is read by the game manager.

8. The player is given a specified amount of time to think of an answer; the time varies from 5 to 30 seconds, depending on difficulty of the problem.

9. The player answers the problem.

10. The game manager then asks if other players agree.
   (a) If they do, and if the answer is correct, the game manager moves the answering player's (or team) magnetic marker ahead the number of chains assigned to the problem.
   (b) If the other players do not agree, and if the answer is correct, the answering player must explain why it is correct before his marker is moved.
   (c) If the other players do not agree, and if the answer or any part is wrong, the answering player loses the same number of chains of fireline assigned to the problem, and his marker is moved back.

11. The next player, and the others in turn, then proceed as above. This procedure forces participation and alertness of all players.

12. The first player (or team) to move completely around the fire wins the game.

The game manager acts as a referee and leader to bring out discussion by all players and to further specific training objectives. He also uses the game to present problems that will bring out key training points he wishes to stress.

Some examples of typical problems for the ground tanker exercise are as follows:

1-Chain problem (low level of difficulty).—Don hands you a wrench to tighten a valve on your tanker. Do you use it? If not, why not? (5 sec.)

2-Chain problem (medium level of difficulty).—Wind is a key weather factor affecting fire behavior. Name two other weather factors of concern to the firefighter. (10 sec.)

3-Chain problem (high level of difficulty).—Your fire is burning in highly flammable fuels on a steep slope. You think of standard order No. 10. What is it? (15 sec.)

4-Chain problem (very high level of difficulty).—What are four important factors in determining your point of attack? (30 sec.)

The fireline game, when properly managed, involves the whole crew, develops interest and keen competition. This game can be used for testing and evaluating trainees during fire training sessions.

TILT BED UNIT MOUNTED ON TRACTOR-PLOW TRANSPORT

Santee Ranger District, Francis Marion National Forest[1]

A tilt bed body, modified as mentioned, was used on the Santee Ranger District, Francis Marion National Forest, during the prescribed burning and fire season 1960-61 (fig. 1). The tractor-plow unit was loaded and unloaded approximately 100 times under all operating conditions during the period. No defects or difficulties in design were encountered. The only disadvantage of the tilt bed in contrast to other beds is that it costs more and requires more time for loading and unloading.

Experienced personnel formerly operating the standard droop tail bed all were enthusiastic in their preference for this new tilt bed unit.

Specifications of body:

- Schwartz hydraulic-operated ramp hoist subframe assembly complete with hydraulic-operated winches and approach plate assembly.
- Lift frame: Double 6-inch heavy (13) channel for 21-foot platform.
- Hoist cylinders: Two 5-inch cylinders with 35-inch stroke, 14-ton capacity, Model 120 T.

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[1]Taken from a report on the use of the tilt bed unit submitted by M. J. Dixon, District Ranger. The use of brand names is necessary to report factually on available data. Their use implies no approval of the products to the exclusion of others which may also be suitable.

FIGURE 1.—Tilt bed with tractor and plow loaded and ready to go. Approach plate in rear of bed is down.

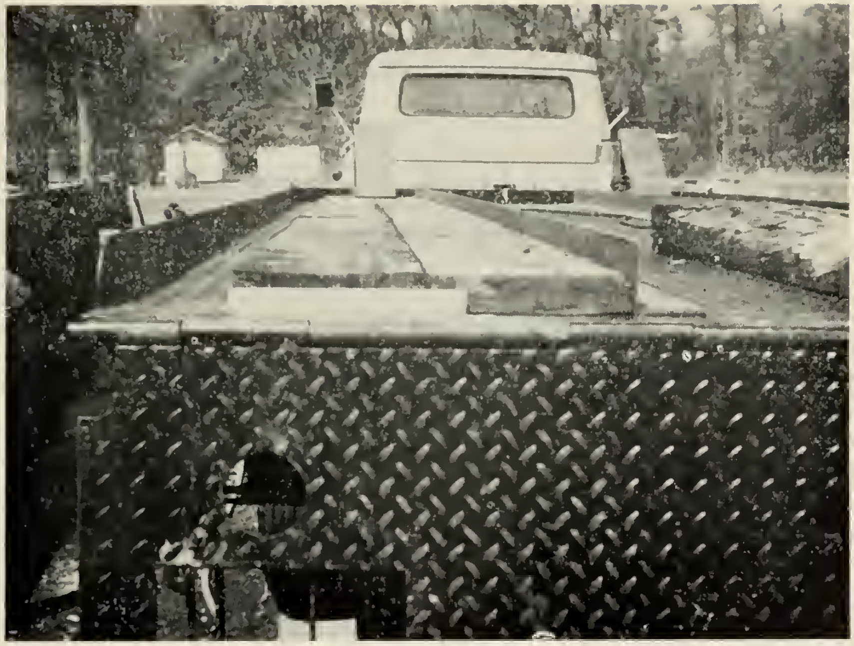


FIGURE 2.—Rear view of bed mounted on truck. Oak planks are 2 by 10 inches for tractor treads. L-irons as track guides are important to prevent side movement while TD-9 is loading.

Winch cylinder: 5-inch, 15,000-pound capacity.
Hold down clamp: Hydra-Spring unit for positive lock and automatic release when bed is raised.
Winch cable: $5/8$-inch.
Winch chain: 6-foot $3/8$-inch.

The tilt bed transport 165-024 was received on the Santee District October 17, 1960, and put into use in November. The complete unit consisted of a Ford T-700 truck, the tilt bed body, and an International TD-9 with a hydraulic Mathis plow attached.

The unit was driven 2,200 miles, for use on 30 wildfires and several prescribed burn areas. This required loading and unloading over 100 times. The unit proved to be a very satisfactory and dependable piece of equipment.

The tilt bed was used as received with the following modifications:

1. The chocks were moved to a position 2 feet back from the front of the bed to distribute the weight evenly over the rear wheels. The balanced weight made the truck easier to drive.
2. A 4-inch by 8-inch by 4-foot timber was bolted to the bed for the coulter and plow point to rest on. This prevented the plow from moving from side to side and injuring the coulter.

3. The tilt bed winch cable was shortened so that it held the TD-9 tracks tight against the chock blocks.

4. A large safety snap hook was attached to the end of the cable for ease in hooking and unhooking the TD-9, which has a steel pin with nut and safety pin.

5. L-shaped grease fittings facing down were installed under the bed of the truck so it can be greased from below. This eliminates raising the bed to get to the fittings.

6. Four oak 2 by 10's were bolted to the bed (two on each side) for the tracks of the TD-9 to run on. On the inside of these planks, two 4-inch L-irons were bolted as track guides to prevent side movement of the TD-9 while loading and in transit (fig. 2).

7. Two chains were attached to the bed with cold links for securing the front of the TD-9 and the plow. Binders were fastened to these chains with cold links to prevent their being lost.

8. A safety step was welded to the front of the bed.

Standard procedure for unloading the TD-9 (fig. 3): (1) With truck engine running, set hand brake; (2) engage bed gear; (3) set throttle to fast idle (the faster the engine runs the faster the bed operates); (4) start tractor, release brakes, and place in neutral gear; (5) raise plow to clear bed; (6) lower bed

FIGURE 3.—Tractor and plow being unloaded from tilt bed. Operator is manipulating controls. This is the maximum elevation of bed. Tractor and plow are descending slowly; held back by cable. Operator can ease the tractor unit down. Weight and momentum of tractor-plow unit permit sufficient descent until all except the last cleat of tractor is on ground. Momentum is not sufficient to have all of the treads flat on ground. Note approach plate is parallel.

to ground; (7) let winch out until tractor stops; (8) unhook winch cable; (9) drive TD-9 away; (10) turn off truck engine.

To load, the procedure is reversed.

The tilt bed body cost $2,852 complete. A droop tail body mounted on an identical transport cost $1,200. In our opinion, however, the tilt bed body is superior to the droop tail and worth the extra cost. There are no heavy runners to handle; this eliminates a danger of ruptures. Danger of tractor falling from bed and injuring driver is reduced. Loading and unloading are easier and safer; tractor is under control from ground at all times. An expert tractor operator is not needed to handle loading and unloading; personnel trained in elementary operation can handle this procedure. Truck can be used to haul other equipment and is more versatile. The entire unit is shorter than the droop tail when the approach assembly is down. The truck handles better than conventional droop tails.

FOREST DISPLAY RACK

Arcadia Equipment Development Center, U.S. Forest Service

Time and again fire protection personnel and resource officers are called upon to exhibit a wide variety of items. Foresters often display posters, photographs, timber products, collections, or new tools at ranger stations, at fairs, and in public buildings. At this Center we have found that these requests involve quite an investment, especially in man-days. It appeared that a little more care in initial layout could make such displays usable for many occasions. Much of our show material was being seriously damaged, primarily in transit and in storage.

For our use we needed a large mounting surface. Often several display boards were required and this created a transportation problem with vehicle space at a premium. Excessive "wear and tear" was another consideration. To help overcome these limitations we designed and built several racks including the features described in the following paragraphs.

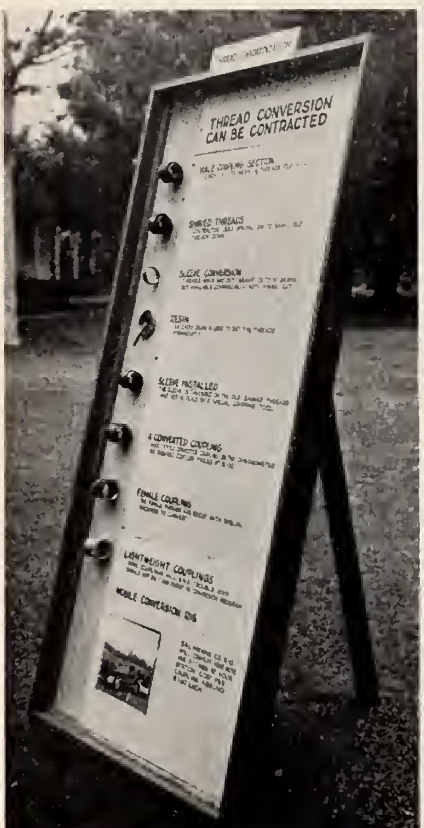


FIGURE 1.—Large display board in use at 1961 fire chief's meeting; section showing molding, exposed area of monk's cloth, and exhibit materials and explanation.

FIGURE 2.—The smaller display board demonstrating hose thread standardization.

A 36- by 68-inch section of ¼-inch pegboard was covered with good-quality monk's cloth. A sturdy frame of 1- by 4-inch material was fitted around the board (fig. 1). The board was held in the frame by quarter-round base shoe fastened with long wood screws. Assuming that there would often be display items on the board while in transit, the back was recessed as deeply as possible in the frame to protect them. Each display rack was carefully tailored to lie flat in the bed of a station wagon and, if necessary, several could be stacked.

A leg of 1- by 4-inch material has been hinged to the top of the frame. A chain keeps the leg from swinging out too far. When not in use the leg is pinned flat to the back of the rack.

We also built a smaller display rack which sits nicely on the top of a fire camp table. This 24- by 48-inch unit (fig. 2) is supported by two short legs.

The monk's cloth covers the holes in the pegboard and lends an attractive, professional appearance. The yardage is not costly and provides a good surface on which to mount or hang pictures and posters. If the peg holes are used the threads of the loosely woven cloth can be easily separated without damage.

This display board offers a large mounting area on a sturdy, easy-to-handle rack. The exhibit is protected in transport and in storage. After long hard miles on the road and a number of scheduled showings the basic material is still neat in appearance and ready for the next assignment. We believe the cost of the display rack will be saved many times over.

INCREASING THE HEIGHT OF STEEL FIRE LOOKOUT TOWERS

OWEN T. JAMISON
Fire Staff, Georgia National Forests

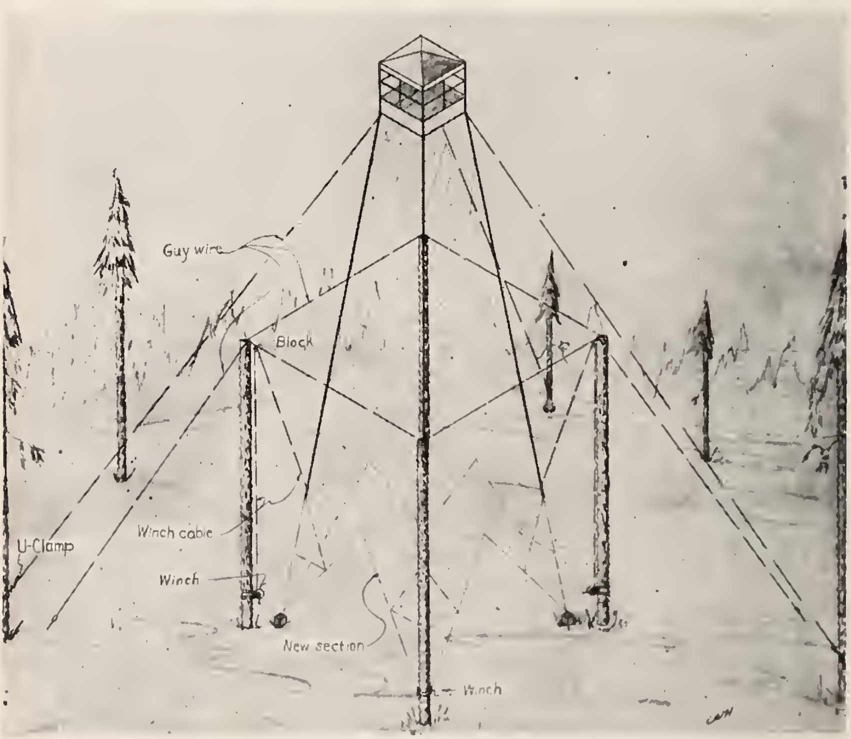
On high site index areas, especially in the South and Southeast Coastal Plains, timber growth is blocking visibility from many fire lookout towers. In such level areas, cutting trees near the tower will not restore adequate visibility.

The Croatan Tower, Croatan National Forest, New Bern, N. C., was blocked in by 60-year-old loblolly pines in 1960. The decision was made to increase the height of the tower from 100 to 120 feet.

Rather than dismantle the tower, the contractor lifted the entire tower 20 feet and bolted in the new 20-foot section.

The following steps illustrate how the job was done:

1. Larger and wider spaced foundations were constructed to the tower manufacturer's specifications.
2. Four 50-foot poles, one on the outside of each of the new foundations, were set. Cross braces were installed on



the poles at ground level to give more bearing surface in the soft soil. These poles were green, unpeeled loblolly pines.

3. The poles were guyed well to ground anchors and tied together at the top and midpoint. A powerline construction crew subcontracted this rigging job.

4. Heavy hand-cranked winches were attached to the poles.

5. One-half-inch wire rope was threaded from the winch spools, up through blocks at the top of the poles, then down and attached to the tower legs near the base.

6. Three-fourths-inch wire rope guys were attached to each top corner of the tower and to trees or other anchors 150-200 feet from the base of the tower. U-bolt clamps were used to secure these guy wires.

7. The base of the tower was unbolted from the old foundation.

8. The tower was centered between the new foundations by rolling on pipe rollers.

9. The new 20-foot section was then fabricated onto the new foundations.

10. Four men, each operating a hand winch, raised the tower evenly within the new steel base section.

11. When the top guy wires became taut, the U-bolt clamps were loosened on one guy wire at a time and the guy wire allowed to sag about 2 feet.

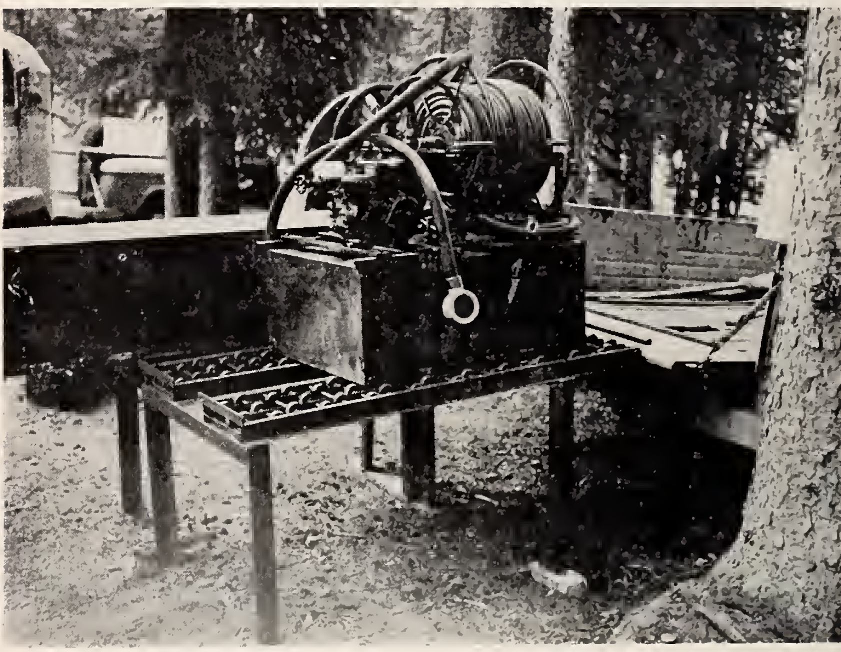
12. When the base of the tower was raised up to the top of the new section, the two parts were bolted together.

Steps #7-12 were finished in one working day to minimize the chance of an unfavorable weather change.

FIRE PUMP AND TOOL BOX LOADING PLATFORM

LYNN H. JONES, *General District Assistant*, and EDWARD D. DAY, *Assistant Ranger, Hahns Peak District, Routt National Forest*

This loading platform makes it possible for one man to load a 50- to 100-gallon pumper full of water or a 10-man fire tool box in a pickup. It consists of track rollers welded to ¼-inch angle-iron legs, 2 by 2 inches in size, with cross braces of the same size. The rollers extend 6 inches beyond the legs on the loading side. The bottom of the rollers can be slightly higher than the pickup



bed so that the truck can back under the rollers with the end gate down.

The pumper unit or tool box can be rolled into the truck on two or three pieces of 1-inch pipe. When the pumper is loaded, it should be blocked to prevent rolling around while traveling. Cost of the platform for a pump is $20 plus cost of the track rollers, which varies depending on the quality purchased.

POSSIBILITIES FOR USE OF A TEACHING MACHINE

BERT HOLTBY
Forester, Division of Fire Control, U.S. Forest Service

There is no argument about the need for highly trained fire personnel; we know that after we have set objectives and policies, organized, staffed, and established controls, the successful accomplishment of the fire management job depends on the performance of the assigned firemen and fire officers. The efficient performance of these men is largely built through successful training efforts, combined with experience.

Most wildland fire control leaders have long been concerned with the challenge of how to effectively train sizable numbers of personnel to accomplish a fire management job of increasing complexity. The sharp buildup in fire personnel during the fire season, the high rate of turnover of part-time employees from year to year, the increased use of specialized fireline equipment, the development of air attack, and the need to train more individuals in more subjects, are but a few of the factors complicating our training effort.

Military and industrial organizations have faced similar problems due to the growth and complexity of "space age" technology. Since the end of World War II, there has been a concerted effort by many military and private organizations to improve training programs to meet these changing requirements.

Likewise, much effort has resulted in some improvements in fire training approaches, methods, and tools. However, in the United States the general approach has remained about the same over the past 20 years.

Now, however, we have the opportunity to use a newly developed training approach, with its special tool the teaching machine. This could provide a major improvement in our overall training efforts.

During the past year a number of newspapers and periodicals have printed articles on this training tool—the teaching machine containing programed learning or self-instructional lessons. These articles have aroused interest among many individuals and organizations, who are also looking for an efficient method to help meet their increased training requirements. Most of these articles have indicated that through the proper use of teaching machines more effective training can be done in less time.

What is a teaching machine? For our purpose we can define it simply as a "device operated by the trainee which presents a lesson in such a way that it may be understood and retained". Some of the significance of such a device may be seen in these points.

1. Instruction is provided by a written "program," which is presented by means of a machine, independent of instructor assistance.
2. Learning occurs at the individual's rate of speed.
3. Two-way communication is provided between the machine and the learner, the trainee receives immediate knowledge of his progress.
4. The lesson sequence is presented in a series of instructional items which require immediate trainee reply.

The machine is only the vehicle that presents the lesson or instructional materials. To understand the principles of the teaching machine approach, let us describe a typical operation:

1. The trainee is seated before the teaching device.
2. It presents information, illustrations, and questions or problems by means of say a 35-mm. filmstrip.
3. The trainee studies the information and answers the questions and problems by selecting from several possible answers.
4. The trainee then pushes one of several response buttons.
5. The button action uncovers the answer and indicates whether or not it is correct.
   a. If not correct, the machine so indicates and shows some additional information to allow the trainee to understand the training point or idea.
   b. If correct, the trainee turns to the next item.
6. This process continues until all the lesson has been presented and answered correctly by the trainee.

Teaching machines are not new. A very early effort in this country was made by a scientist in 1866; but the present teaching machine work was started about 1926 at Ohio State University by Dr. Sidney Pressey. It was not, however, until the early 1950's that a number of educational leaders in the United States recognized the value of a device that permitted the learner to take an active role in the learning process and to provide him with immediate knowledge of his performance. By 1959 national interest had developed to a high point as evidenced by a growing number of research and development projects carried on in many universities and in a number of military and industrial organizations.

During 1960 and 1961 interest in the teaching machine grew at an extremely fast rate. The available machines vary greatly in size, complexity, and cost.

Psychologists have performed many experiments that show a person usually learns best when—

1. He learns easily.
2. He does something as he learns, that is, "learns by doing."
3. He receives a reward for learning.

Any successful teaching program is based on these three psychological learning principles.

Psychologists also point out that a trainee becomes discouraged when he has trouble with a subject, arithmetic, for example, and makes many mistakes in each day's lesson. Often the trainee says

he "hates" a subject, and may develop an unconscious block, or barrier, against learning it.

"If he can learn arithmetic without making mistakes as he goes along," the psychologists say, "he will not build up a mental block against it. And in that case he will work at it willingly and enthusiastically."

Many people are amazed when they hear that students can go through an entire teaching machine program without making, at most, more than a few mistakes. Some people think this means that the students have not really learned anything new.

Tests based on controlled experimental studies, have proved that students do learn in a carefully designed teaching machine course. For example, one class of 8th-grade students finished a whole year's work in algebra in less than one term by the use of teaching machines. They took an algebra test, together with another class of students who had spent a full year studying the same course under conventional methods. The machine-using students received higher marks than those in the other group.

A year later, on a similar test, the machine-users again received high marks. This proved that they still knew the lessons learned many months before.

The program inside the machine.—The lesson, on filmstrip, inside a teaching machine is prepared by a method called programing.

This is how an "expert" goes about programing a subject:

1. First, he breaks the subject down into dozens, or even hundreds, of small steps, or frames. Each step leads to the next, and makes that next step easy to understand.
2. Second, he adds to each frame a question, or questions, that will test the trainee's understanding of what he has just read. The trainee may be asked to work out some problem. He may be shown several possible answers (multiple choice) and asked to choose the right one. Often a question will be asked in several different ways in different frames, to make sure that the trainee really understands what he has seen and read.
3. Third, at the end of each step, the correct answer is given to each question that has been asked in that frame.
4. Fourth, the important steps are repeated in different words and at different places in the program, so that the trainee can review what he has already learned and strengthen his understanding of it.

The most successful programs have been prepared by a team consisting of subject matter specialists, training specialists (or training psychologists), and visual aid specialists.

Developing teaching machine lesson plans is no easy or simple matter. Even with good existing "human" lesson plans, it is a tedious, detailed job requiring much analysis and work to present the material point by point in a logical sequence with reinforcing information. Also, expert technical assistance is needed in preparing graphics, photographs, and visual displays to strengthen the key points in the training material.

Each word in a successful program is designed to buy something in the way of learning, and all unnecessary verbiage is cut out, "chunk by chunk," then "piece by piece," and then "sliver by sliver."

A pilot plant development was started in 1961 by the U.S. Forest Service working with a corporation primarily engaged in the design and development of large, computerized information processing systems. The machine designed for pilot plant use is known as the ikor (immediate knowledge of results). Information, visual aids, and questions are projected onto a screen at the front of the machine.

The program selected for this 'pilot plant' effort is a one hour advanced fire behavior lesson on clouds and associated fire weather.

The lesson has been developed in four parts:

Part I—What are clouds? (A quick review.)
Part II—How are they formed? (A quick review.)
Part III—What type of clouds are there? (A quick review.)
Part IV—What effect do the various types of clouds indicate in terms of associated fire weather? (Main part of lesson.)

Here is an example of *one item* from Part II of the lesson:

(Advanced Fire Behavior) Item 11

WE HAVE JUST DISCUSSED TYPES OF CLOUDS, AND HOW THEY ARE FORMED. NOW, REMEMBER WE ARE ONLY REVIEWING CLOUD *FORMATION*.
NOW, WHAT DO YOU THINK WOULD HAPPEN IF A STRONG WIND ARISES IN THE AREA WE JUST DISCUSSED?

1. Adiabatic cooling takes place and the vapor content of the air becomes uniform.
2. The air mixes and the warmer air at the ground cools as it rises.
3. The cool air high above the ground mixes with the warm air and the warm air cools down.
4. The cool air mixes with the warm air and it warms up.

Feedback to the trainee depends on which button he pushes (figs. 1 and 2):

1. Correct—Good!
   Go to Item 16.
2. No—but almost
   right. Go to Item 13.
3. Wrong—not complete.
   Go to Item 14.
4. Wrong—incomplete.
   Go to Item 15.

In developing the feedback some items are often illustrated with pictures and might be written as follows:

Item 16. Yes! That's exactly what would happen. In the top part of the layer of air the process of MIXING has

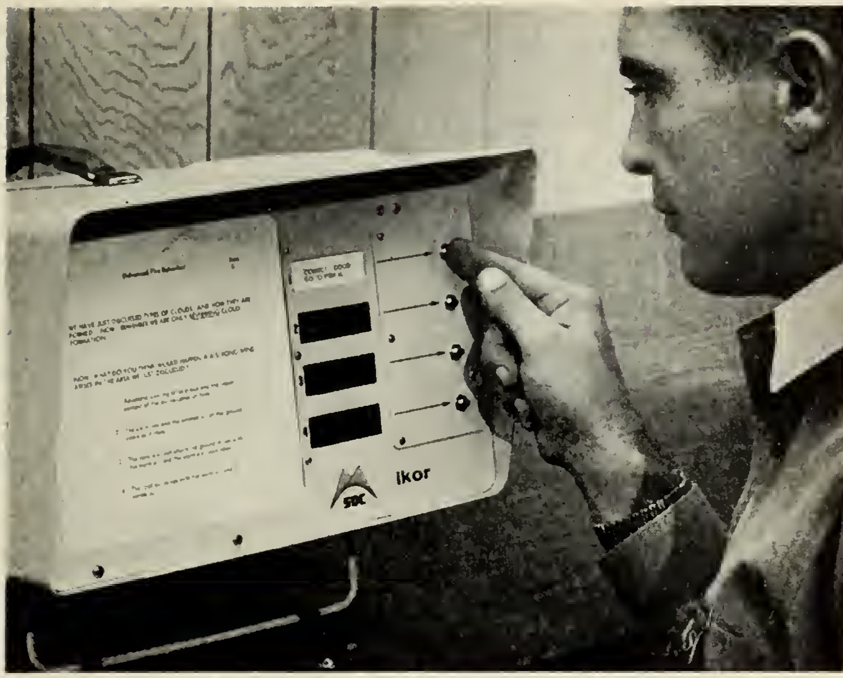


FIGURE 1.—A manually operated teaching machine designed and developed for research in programed learning techniques.

FIGURE 2.—Trainee turning handle to next training item.

created a cooling and an addition of water vapor effect. If enough MIXING takes place, a cloud will form at the top of this body of air.
Remember this though, MIXING usually occurs close to the ground.
Go to Item 17.

Item 13. That's true all right! But you forgot about the *water vapor* part of the MIXING.
Turn back to Item 11 and choose another answer.

Item 14. That's so. However, several other things happen at the same time.
Go back to Item 7 and review.

Item 15. Correct—as far as you went! Several other interesting and important phenomena occur in the process of MIXING.
Turn back to Item 7 and study it carefully. Answer all questions completely as you continue through the section on MIXING.

Part IV of the pilot plant program might begin like this:

Item 62

WE WILL NOW TALK ABOUT HOW CLOUDS ARE INDICATORS OF THE FOLLOWING *IMPORTANT* FIRE-WEATHER VARIABLES:

(a) Wind
(b) Fuel Moisture
(c) Fuel Temperature
(d) Atmospheric Stability
(e) Precipitation

BECAUSE CLOUDS ARE USUALLY ONLY THE RESULTS OF WHAT IS HAPPENING IN THE *ATMOSPHERE*, RATHER THAN THE *CAUSE* OF ATMOSPHERIC CHANGES, WE FIND THAT . . . etc.

The total pilot plant teaching machine program in advanced fire behavior will be demonstrated at the U.S. Forest Service National Training Workshop in January 1962.

A teaching machine with a carefully designed learning program is a "bridge" that permits expert instructors to reach students and to serve each as a private tutor. The idea of a private tutor is probably as old as mankind.

The teaching machine as a training tool is certainly not a magical device; without an efficient program inside it, the machine is simply an empty box. Some significant values in the use of teaching machines are—

1. They provide clear, concise, and complete training when needed, rather than when a "class" and instructor are available.
2. They present uniform information and require frequent responses by the trainee.
3. They provide immediate feedback to the trainee, in-

forming him whether his answer or analysis is correct or not.

4. They allow the trainee to work individually, and to adjust his own rate of progress to his needs and capabilities.

5. They easily provide refresher training.

This tool, if properly fitted into an overall training program, could help provide more effective training and bring about a saving in time.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustrations. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproductions. Please therefore submit well-drawn tracings instead of prints.

remember- only YOU can

PREVENT FOREST FIRES!